Nova Scotia

Department of
Mines and Energy

Canada – Nova Scotia
Mineral Development Agreement

PO Box 1087 | 1690 Hollis Street | Halifax, Nova Scotia | B3J 2X1

OPEN FILE REPORT 621

EFFECTS OF LOCATION ON MINE DEVELOPMENT POTENTIAL: NOVA SCOTIA'S COMPETITIVE POSITION IN CANADA

Prepared for

Department of Mines and Energy
Government of Nova Scotia

by

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Centre for Resource Studies
May, 1985

FOREWORD

This study was prepared by the Centre for Resource Studies under contract to the Nova Scotia Department of Mines and Energy, with funding provided through the Canada-Nova Scotia Mineral Development Agreement.

The views expressed are those of the authors, and do not necessarily represent the views of the Nova Scotia Government, or of the Centre for Resource Studies or its sponsors.

ACKNOWLEDGEMENTS

We would like to express our appreciation and thanks to the large number of government and mining company officials who provided us with the information required for this study. In particular, the support of the following individuals is gratefully acknowledged: Bob Keyes and Gerald Pelletier of Energy, Mines and Resources Canada for advice on wage rates and workers' compensation payments; George Penna and Michael Power of Noranda for help with the tax calculations and more general counsel; and Peter Munro of Dickenson Mines for data on required inputs for mine development and production. Finally, we would like to thank Patrick Hannon, Nova Scotia Department of Mines and Energy, for constructive advice and liaison during the course of the study.

SUMMARY

The variable economic conditions which exist within Canada have a direct bearing on mine development and mineral exploration potential. The study examines locational aspects of Nova Scotia's competitive position relative to other Canadian regions and provinces.

This assesament of competitive position concerns two hypothetical mineral deposits, representing exploration targets of interest in Nova Scotia: a medium-size open pit tungsten deposit, and a small underground gold deposit.

The possible development of these deposits is evaluated on the basis of current economic and technological outlook conditions. General economic conditions and deposit-specific characteristics, held constant throughout the study, are initially applied to provide cash flow estimates for Nova Scotia 'base cases'. Then, regional economic differences and less-accessible site conditions are imposed to evaluate the economics of developing the tungsten and gold deposits in central Canada and in western Canada. Finally, these projects are subjected to taxation in Nova Scotia, New Brunswick, Newfoundland, Quebec, Ontario, Manitoba, Saskatchewan, and British Columbia. Five types of taxation payment are incorporated in the analysis: federal corporate income tax, provincial corporate income tax, provincial mining tax, provincial royalty, and selected non-profit taxes.

The study comprises three stages of evaluation and analysis:

1. Before-tax economic effects of location. Discounted cash flow criteria and breakeven ore grades are assessed for the Nova Scotia base cases, similar 'more-accessible' sites in central and western Canada, and deposit accessibility variants including 'less-accessible' mine-sites, and regional processing of the gold ore at the more-accessible sites.

2. Effects of taxation among provinces. To isolate taxation effects, all other evaluation components are held constant. The Nova Scotia base cases are used to provide this common standard. The taxation effects examined include after-tax measures of investment incentive, level and components of total tax payments, company and government shares of before-tax project value, tax payments as a proportion of total project costs, and after-tax breakeven ore grades.

3. Combined impact of before-tax and taxation conditions. The before-tax region and site variants are combined with appropriate provincial tax systems for the evaluation of after-tax economic indicators.

With respect to the before-tax effects of location, the tungsten and gold projects are both shown to be economically viable throughout Canada, offering reasonable prospects for wealth creation. However, project economics are highly sensitive to metal price and cost of capital projections.

The study findings indicate that the tungsten and gold projects in Nova Scotia generally provide more favourable economic results than the same mine development opportunities located in central Canada and, particularly, in western Canada. For example, the before-tax net present value of the tungsten project varies from $75.9 million in Nova Scotia to $35.6 million at the less-accessible site in western Canada.

The main before-tax advantages of a Nova Scotia location are found to be relatively lower wage and salary rates, and a high density of infrastructure. These benefits are only partially offset by higher electrical power charges.

The regional processing opportunity significantly enhances the economic potential of the small gold project in all regions. For example, the project rate of return in Nova Scotia increases from 25.5 percent to 33.9 percent.

Existing taxation systems impose a heavy cost burden on the tungsten and gold projects throughout Canada. However, there are striking differences in tax levels and effects among individual provinces.

The taxation regime in Nova Scotia is found to be among the most favourable in Canada in terms of after-tax investment incentive. For example, in the case of the tungsten project, assuming the individual project basis of taxation, the present value of tax payments (discounted using a riskless rate of 3 percent) varies from $112 million in Nova Scotia to $164 million in British Columbia. This difference mainly reflects the much higher non-profit taxes payable in British Columbia.

Company profit and government taxation shares of the before-tax net present value vary accordingly, in the case of the tungsten project from 33-67 percent in Nova Scotia to 0-100 percent in British Columbia. Expressed another way, tax payments as a proportion of total project costs increase from 14.7 percent in Nova Scotia to 20.6 percent in British Columbia.

After-tax measures of investment incentive are significantly enhanced by the integrated company basis of taxation. However, the competitive provincial rankings remain essentially unchanged.

Finally, the combined impact of before-tax and taxation conditions is examined. Generally, the before-tax and taxation competitive rankings tend to be positively correlated. Thus, their combined impact generally widens the locational differences among provinces. In all cases, Nova Scotia is found to be the most competitive location and British Columbia the least competitive location for investment.

The combined effects of location may be viewed in terms of the breakeven ore grades required to achieve a minimum acceptable return on investment, say 10 percent. In the case of the gold deposit, this breakeven grade is shown to vary from 8.13 grams of gold per tonne in the Nova Scotia and New Brunswick locations to 12.83 grams of gold per tonne at the less-accessible site in British Columbia. Thus, undiscovered gold deposits with grades between 8.13 and 12.83 grams per tonne constitute economic exploration targets in the former cases but would be uneconomic in the latter situation.

In terms of locational conditions affecting competitive position for mineral exploration and development funds, study results indicate that Nova Scotia ranks at the top of the league of Canadian provinces.

It is hoped that the study results will be interpreted and used with a clear understanding of the limitations embodied in this initial examination of an important and complex topic.

The study is restricted to an examination of the effects of location on competitive position. Differences in the inherent geological quality of mineral resources among regions and provinces are not considered. These deposit-specific characteristics are considered here to be common to all locations and are, therefore, held constant throughout the analysis.

The following omissions and uncertainties should also to noted:

- the full impact of the federal corporate income tax investment credit for projects in the Atlantic provinces and the Gaspé region of Quebec has inadvertently been neglected. Consequently, after-tax results for Newfoundland, New Brunswick, and Nova Scotia relative to the other provinces are more favourable than shown.

- the provincial tax on electricity used by mining operations which exists in Newfoundland, Manitoba, Saskatchewan, and British Columbia, has not been considered.

- we have found property taxes particularly difficult to estimate with any semblance of reliability. Most importantly, it is difficult to generalize on property tax burdens within each province. Further work needs to be done on this key aspect of non-profit taxes to provide a more realistic range of possible property tax payments within each province.

These shortcomings reflect a compromise between the ready availability of information and expertise and the research limitations imposed by

time constraints. We feel that the margin of error which exists in the analysis due to these shortcomings is not large enough to affect the reliability of the overall conclusions. There is, nevertheless, scope for improvement.

While the study was being completed, two significant tax changes have been announced - a phase-down in the non-profit tax burden on mineral projects in British Columbia, and replacement of the progressive mining tax rate schedule in Quebec with a flat-rate tax. The upcoming federal budget may bring further changes. It would be interesting to evaluate the sensitivity of our results to these current policy changes.

Finally, one aspect of the effects of location on the economics of prospective exploration targets and mine development opportunities is the distance and transportation cost from minesite to the market place. Although our evaluation procedure incorporates this variable, the gold bullion and tungsten concentrate products of the representative mine projects examined have such high unit values that economic results are essentially insensitive to transportation costs. A parallel evaluation might usefully be carried out for a lower unit value mineral commodity, coal or one of the industrial minerals for example, to examine this aspect of locational economics.

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1. INTRODUCTION

Study Setting

The economic potential of mineral supply may be assessed in a number of ways. One approach, which is finding increasing use for both corporate planning and government policy purposes, is to evaluate the competitive position of an actual or potential mineral producer in the international marketplace relative to other suppliers.

Such examinations of competitive position vary from cost league comparisons of breakeven costs for operating mines, through the assessment of relative costs associated with developing new productive capacity, to long-term evaluations of the economics of mineral exploration. The complexity of the analysis increases with the scope and timeframe of interest. Many factors are usually involved. One important aspect of competitive position is the quality of the resource base itself. Other key factors include available technology, wage and salary rates, labour productivity, the cost of capital, infrastructure requirements, distances from sources of materials supply and to mineral markets, the quality of management, organizational efficiency, government mineral policies including taxation, and inflation and exchange rates. The present study fits within this general competitive position framework.

The economic differences which exist among the regions and provinces of Canada influence the potential for mine development and mineral exploration. This study examines the variability in competitive position which arises within Canada from locational conditions.

Objectives and Scope of Work

The objectives of our study are to:

- develop a procedure for examining the effects of location on the economics of developing mineral deposits;
- apply this procedure to evaluate locational aspects of Nova Scotia's competitive position for mine development relative to other Canadian regions and provinces.

In so doing, the study is intended to foster an improved understanding of economic exploration targets and a more informed basis for exploration planning within the province of Nova Scotia.

Two hypothetical mine development opportunities, representing exploration targets of interest in Nova Scotia, are used to make the requisite comparisons: a medium-size open pit tungsten project, and a small underground gold project. These potential mines are initially evaluated in Nova Scotia and, then, in a number of other Canadian regions and provinces.

Market price conditions and representative deposit characteristics are held constant throughout the analysis. Cash flow estimates are modified for differences in regional economic conditions, deposit accessibility in relation to established infrastructure, and provincial and federal taxation policies. A number of economic criteria are assessed for each study variant. Results, reflecting the effects of location on competitive position, are presented and compared.

Organization of Study

Chapter 2 describes the methodology which is applied to assess the economic effects of location. Attention is given to the basic evaluation components considered, the three stages of analysis carried out, and the economic criteria utilized.

The assembly of information for use in the study is discussed in chapter 3. Study terms of reference and general assumptions are outlined. Descriptions are given of the representative tungsten and gold projects. Cash flow estimates are initially made for a Nova Scotia 'base case' and, then, these are modified for the other regions and deposit sites considered. Finally, an outline is given of the various federal and provincial taxation regimes applied.

Chapters 4-6 present and compare the study results. The before-tax economic effects of deposit location are analyzed in chapter 4. Chapter 5 concerns taxation effects among provinces. The combined impact of the before-tax and taxation locational conditions are evaluated and compared in chapter 6.

Two matters relating to the cash flow estimates discussed in the text are described in greater detail in the appendices.

2. ASSESSING THE ECONOMIC EFFECTS OF LOCATION

General Approach

The variables which determine the economics of mine development may be broadly grouped into those which are influenced by deposit location and those which are independent of location.

The locational factors may be further subdivided into three categories, according to whether the influence of location arises from:

- regional economic conditions;
- the site of a deposit within a region in relation to established infrastructure;
- taxation conditions.

The non-locational factors, on the other hand, include:

- general economic conditions;
- deposit-specific characteristics.

Thus, we are dealing with five basic evaluation components, three of which depend on deposit location, and two of which are independent of location.

The methodology adopted in this study is based on two tenets. First, in order to isolate the effects of deposit location, the non-locational factors should be held constant. Second, in order to understand and explain locational differences, the locational components should be examined one at a time before being combined. Following this procedure, the study comprises three stages of evaluation and analysis:

1. Before-tax economic effects. Initially, the influence of differences in regional economic conditions is assessed. Then, consideration is given to the influence of the deposit site within a region.

2. Effects of taxation. To isolate the consequence of taxation, all other evaluation components are assumed to remain constant.

3. Having developed an understanding of before-tax and taxation effects separately, the combined impact of all locational components is assessed.

This general procedure is applied to analyze the effects of location utilizing the representative tungsten and gold deposit case studies.

We now proceed to outline the variables considered within each of the five basic evaluation components, the way in which these components are combined in the three stages of evaluation and analysis, and the economic criteria which are applied within each stage.

Basic Evaluation Components

Study estimates are based on 1985 current outlook conditions. The time-frame for the estimates is the combined development and production periods of the hypothetical mines being evaluated. All money values are expressed in constant 1985 dollars (Canadian dollars, unless otherwise stated).

General Economic Conditions

General economic conditions are considered to be independent of deposit location. For purposes of evaluating the tungsten and gold mine development opportunities, the following estimates and assumptions are required:

- currently available mining and mineral processing technology;
- average mineral commodity price projections in U.S. dollars for expected, lower-limit, and upper-limit conditions;
- U.S. dollar:Canadian dollar exchange rate for expected, lower-limit, and upper-limit conditions;
- weighted average cost-of-capital discount and hurdle rate for expected, high, and low conditions;
- general rate of inflation to correctly assess tax allowances and payments.

Deposit-Specific Characteristics

A number of parameters in the evaluation reflect the geological dimensions of the representative tungsten and gold deposits. These deposit-specific characteristics are considered here to be common to all locations and are, therefore, held constant throughout the study. In this regard, estimates and assumptions are required for the following project parameters:

- geological deposit setting;
- recoverable ore reserve tonnage;
- recoverable ore reserve grade;[1]
- mine and mill capacity;
- mining method;
- average stripping ratio (for the open pit tungsten mine);
- mineral processing flowsheet;
- mill recovery factors;
- product specifications;
- preproduction development period;
- on-site person-hours of employment required to develop mine and construct related facilities;
- employment during the productive mine life;
- electrical power and fuel consumption during production.

Regional Economic Conditions

The tungsten and gold mine development opportunities are initially evaluated assuming that they occur at a typical site in Nova Scotia. The estimates and results associated with this situation, termed 'base case conditions', provide a standard for comparison with other study variants.[2]

Following the assessment of these base cases, the tungsten and gold deposits are hypothetically relocated to sites in:

- central Canada;
- western Canada.

In each case, modifications are made to the cash flow estimates to allow for regional differences in:

- wage and salary rates;
- electrical power charges;

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1. Grades are selected to be realistic in terms of achievable exploration targets. Within possible geological limits, deposit grades are chosen to provide 'reasonable' before-tax rates of return for the mining projects in their 'base case' Nova Scotia location; about 18 percent for the tungsten project and 25 percent in the case of the gold project. For the evaluation of breakeven grades, the grades required to achieve a minimum acceptable economic result are in each case determined.
2. More generally, this Nova Scotia site is considered to be representative of conditions existing in eastern Canada.

- working capital requirements;
- market locations and distances, in the case of the tungsten project.

These are the only regional factors considered in the study. For example, it is assumed that the deposit sites in each of the three regions are equally well located with respect to the cost of providing materials and supplies for construction and production.

Deposit Accessibility

For the Nova Scotia base cases, it is assumed that the tungsten and gold deposits occur 10 kilometres from established road, powerline, housing and townsite facilities. More generally, this premise is considered to be representative of eastern Canada where there is a relatively high density of infrastructure.

Within the central Canada and western Canada regions, two possible deposit sites are evaluated. Initially, estimates for the tungsten and gold projects are based on a more-accessible site, similar to the Nova Scotia base cases, occurring 10 kilometres from existing infrastructure. Then, a less-accessible site is considered, 50 kilometres from established road, powerline, housing and townsite facilities. In this case, daily commuting by bus from an existing townsite is assumed. Adjustments are made to the cash flow estimates within each region to allow for cost differences between the deposit sites arising from:

- the amount of infrastructure required;
- the direct and time costs associated with the daily bus commuting activity;[3]
- working capital requirements.

These central Canada and western Canada deposit site variants enable us to evaluate the sensitivity of mineral development potential to this aspect of location. The more-accessible and less-accessible sites in central and western Canada may both be regarded as favourable since discoveries in these regions are often even farther than 50 kilometres from established infrastructure. However, the intention has been to structure accessibility variants of the same order as considered for the Nova Scotia base case.

The analysis generally assumes that a separate processing facility is required for the tungsten and gold projects at each site. The economic

3. The assumption is made that one-half of the commuting time is paid for by the mining operation in terms of higher wage and salary payments, the other half being absorbed by the employees.

effects of the availability of an existing concentrating plant for the small gold deposit at the more-accessible sites are assessed as a variant. In this case, only the incremental capital, operating, and transportation costs are allocated to the gold project.

Taxation Regimes

The introduction of taxation into the analysis requires more specific consideration of locational effects among individual provinces. For study purposes, the tungsten and gold projects are subjected to taxation in:

- Nova Scotia;
- New Brunswick;
- Newfoundland;
- Quebec;
- Ontario;
- Manitoba;
- Saskatchewan;
- British Columbia.

The study considers actual Canadian taxation systems existing in January 1985. Five types of taxation payment are incorporated in the analysis:

- federal corporate income tax;
- provincial corporate income tax;
- provincial mining tax;
- provincial royalty;[4]
- selected non-profit taxes.

The non-profit taxes considered have been selected on the basis of both their perceived importance and the relative ease with which they can be defined and estimated. These include:

- provincial sales tax;
- provincial fuel tax;

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4. The distinction between provincial royalty and mining tax payments made for study purposes is that royalties are levied on gross income or revenue whereas mining tax is based on net income or profit.

- corporation capital tax;
- workers' compensation payments;[5]
- property taxes.[6]

Non-profit taxes take the form of capital and operating costs and, generally speaking, are allowable deductions for income and mining tax purposes in the same way as before-tax capital and operating costs.[7] This somewhat complicates the determination of taxation effects. Consequently, we have adopted a two-step evaluation procedure. First, the federal and provincial income and mining tax regimes are applied to the before-tax cash flow estimates and the after-tax results are assessed. Then, before-tax capital and operating costs are increased by an amount equal to the non-profit taxes and the after-tax results are reassessed. The difference between the second and first stage assessments represents the effect of the non-profit taxes, net of the credits realized against income and mining taxes.

The study generally assumes that taxation is on an individual project (or stand-alone) basis. In this case, mining taxation allowances are constrained by the availability of production income from the project itself. Thus, it is assumed that the mining company concerned has no existing source of taxable income.

Taxation on an integrated company (or flow-through) basis is considered as a variant. In this case, it is assumed that the company has an existing source of income from other operations. Thus, write-offs may be taken as rapidly as allowed by the tax system against this income stream. The tax credits realized on an integrated company basis will, therefore, be more immediate than on an individual project basis. The benefits of this basis of taxation to the mining company will be shown in our analysis.

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5. May be more properly termed a 'government-mandated cost'. Workers' compensation payments are included because of their magnitude and the variations which exist among provinces.
6. Property taxes certainly do not meet the 'relative ease' test, being extremely difficult to estimate with any semblance of reliability. Most importantly, it is very difficult to generalize on property tax burdens within each province.
7. The only exception we could find is the case of corporation capital tax paid in British Columbia which is not an allowable deduction for provincial mining tax purposes.

Stages of Analysis

The basic evaluation components are integrated in several ways for purposes of carrying out the three required stages of evaluation and analysis.

Before-Tax Economic Effects

In this first stage, the general economic conditions and deposit-specific characteristics are initially applied to estimate revenues, capital costs, and operating costs for the representative tungsten and gold projects in Nova Scotia. Estimates for other regions and deposit sites are then derived from these base case conditions.

Regional economic differences are used to modify the Nova Scotia revenue and cost estimates to the conditions applicable at the more-accessible sites in central Canada and in western Canada. Then, in these two regions, estimates for the tungsten and gold development opportunities are adapted for accessibility differences to derive appropriate revenues and costs for the less-accessible deposit sites. Finally, the gold project estimates at the more-accessible sites in Nova Scotia, central Canada, and western Canada are modified to account for the possible utilization of an existing processing facility.

The main analysis is based on expected future conditions. Sensitivity analysis is applied to evaluate the effects of possible changes in commodity prices, and variations in the discount and hurdle rate.

In each case, a before-tax time distribution of cash flows is derived from the appropriate revenue, capital cost, and operating cost estimates. The following economic criteria are then assessed:

- total revenue;
- net present value;
- rate of return;
- breakeven deposit grade.

Effects of Taxation

The before-tax estimates for the tungsten and gold projects situated in Nova Scotia are used throughout this second stage of evaluation and analysis. Thus, the taxation systems existing in Nova Scotia, New Brunswick, Newfoundland, Quebec, Ontario, Manitoba, Saskatchewan, and British Columbia, are applied in turn to this standard set of before-tax conditions.

The approach adopted may be considered somewhat theoretical because the before-tax cash flows for these projects would actually vary significantly as a function of their assumed location. However, it is only by means of this type of contrived standardization that the consequences of taxation can be isolated.

In each province, the appropriate taxation regime is applied to the standard before-tax estimates to derive an after-tax time distribution of cash flows. The following economic criteria are then evaluated:

- after-tax net present value;
- after-tax rate of return;
- total undiscounted and discounted tax payments;
- tax payment components;
- company and government shares of before-tax value;
- tax payments expressed as a proportion of total project costs;
- after-tax breakeven deposit grade.

Combined Impact of Before-Tax and Taxation Differences

In the final evaluation stage, the differences evaluated in the first two stages are combined to assess the overall effects of location on mine development and exploration potential. For this purpose:

- the before-tax Nova Scotia base cases are used together with the tax regimes in Nova Scotia, New Brunswick, and Newfoundland;
- the before-tax estimates for the tungsten and gold projects in central Canada are combined in turn with the tax systems existing in Quebec, Ontario, Manitoba, and Saskatchewan;
- the taxation regime in British Columbia is applied to the before-tax estimates for western Canada.

Once again, in each case, the after-tax time distribution of cash flows is assessed. The following economic criteria are used to measure the overall impact of location on these mine development opportunities:

- after-tax net present value;
- after-tax rate of return;
- after-tax breakeven deposit grade.

3. FORMULATION OF REPRESENTATIVE MINE DEVELOPMENT CASES

This chapter describes the assumptions and estimates which are made to define and evaluate the representative tungsten and gold projects.

General economic conditions and deposit-specific characteristics provide the basis for evaluating the Nova Scotia base cases. Then, regional economic differences and less-accessible site conditions are applied to assess the economics of developing the tungsten and gold deposits in central Canada and in western Canada. Finally, relevant tax regimes are specified for the eight provinces considered.

General Economic Conditions

The deposits are evaluated on the basis of current economic and technological outlook conditions. Money values are expressed in constant 1985 dollars.[8]

Market Estimates

With regard to metal price projections, an impure bullion product (doré) would be recovered from the gold deposit. The tungsten mine is assumed to produce combined scheelite and wolframite concentrates,[9] containing tungsten trioxide or WO_3; a high-grade 68 percent WO_3 concentrate, and a low-grade 35 percent WO_3 concentrate.

Tungsten concentrate is processed chemically to produce tungstic acid and/or ammonium paratungstate (APT), from which tungsten metal powder is made. The metal powder is then processed further into products such as tungsten carbide and ferrotungsten. The low-grade concentrate must first be shipped to chemical plants to produce market-grade synthetic scheelite.

Metal price projections are made to evaluate the time distribution of revenues for each of the mine development opportunities.

Metal price is both the most important and the most uncertain variable in the assessment of cash flows. Therefore, cash flows are evaluated as a function of price. An expected or mean price outlook is bounded by upper- and lower-limit prices for each commodity. The prices used in the study are shown in table 1. These are long-term average price projec-

8. All discount rates and costs of capital are therefore expressed as 'real' (as opposed to nominal) rates.
9. Scheelite (a calcium tungstate) and wolframite (an iron-manganese tungstate) are the most important tungsten ore minerals. The tungsten deposit mineralization is comprised of a mixture of the two.

Table 1

METAL PRICE PROJECTIONS
(U.S. dollars)

Metal	Price Basis	Lower Limit Prices	Expected Prices	Upper Limit Prices
Gold	per ounce metal	250	350	500
Tungsten	per metric tonne unit of WO_3 in concentrate[a]			
	68% WO_3 concentrate	65	95	130
	35% WO_3 concentrate	49	71	98
Exchange Rate	$US/$C	.90	.80	.75

[a] There are 100 metric tonne units in a metric tonne. Thus, a concentrate grading 68 percent tungsten trioxide (WO_3) contains 68 metric tonne units of WO_3. A metric tonne unit is equivalent to 22.046 pounds.

tions, the period of which is intended to correspond to the timeframe of the tungsten and gold projects being evaluated.[10]

The gold price projections pertain to refined metal at the market. A fixed charge of U.S.$10 per ounce is applied in this study to cover the insurance, transportation, refining and marketing costs associated with converting the impure bullion produced at the minesite to refined metal in the ultimate market.

The basis for the tungsten price is the content of tungsten trioxide (WO_3) in concentrate delivered to the consumer. A tariff of U.S. 17 cents per pound of tungsten contained in concentrate is levied on imports into the United States. Also, the transportation cost of delivering tungsten concentrate from the mine to the market has to be deducted in estimating sales revenue at the minesite. The unit transportation costs used for this purpose, based on container shipment and handling, are given in table 2. The concentrate shipped is assumed to contain 5 percent moisture.

10. The basic United States dollar price estimates have been combined with exchange rate estimates in the way which gives the widest possible Canadian dollar price range. The correlation which exists between metal prices and the exchange rate has not been considered. This correlation would have the effect of increasing the $US/$C exchange rate as a function of metal price.

Table 2

TUNGSTEN CONCENTRATE TRANSPORTATION COSTS
($ per wet tonne of concentrate)

Market Location	Mine Location		
	Nova Scotia	Central Canada	Western Canada
Europe	111	-	-
New York	76	-	-
Pennsylvania	-	82	-
Ohio	-	78	-
California	-	-	85
Japan	-	-	167

Discount and Inflation Rates

A 10-percent discount rate is selected as our best estimate of the weighted average cost of capital (in constant money terms) for investment in the tungsten and gold mine projects. To analyze the sensitivity of results to the cost of capital, assessments are also made for 5 percent and 15 percent rates.

A riskless discount rate of 3 percent is assumed for the evaluation of tax revenues from a government viewpoint. The rationale for doing this is that the government as tax collector, not committing investment funds, bears none of the risk associated with that investment.

Inflation reduces the real constant-money benefits or credits associated with tax write-offs which can only be taken over a future period of time. A 5-percent general rate of inflation is used in the study to evaluate the real effects of taxation.

Deposit-Specific Characteristics

The following estimates and assumptions are formulated as being representative of mineral endowment potential in Nova Scotia. These characteristics, reflecting the geological character of the tungsten and gold deposits, remain constant throughout the study.

Representative Tungsten Deposit

Geological Setting: An idealized section through the representative tungsten deposit is presented in figure 1. This type of tungsten deposit is typically formed where a younger granite stock has intruded a variety of country rocks. Hydrothermal solutions containing tungsten subsequently invaded the top part of the intrusive, forming an irregular but extensive 'greisen' zone within which ore grade mineralization has developed. A partly eroded pegmatitic cap rock, formed along the nearly flat-lying granite contact seals off the greisen system.

The greisen zone reaches a maximum thickness of 50 metres in the central part of the granite, thinning out to 5-10 metres laterally. It develops over a maximum surface of 800 by 800 metres and exhibits a maximum vertical range of 200-250 metres, forming in most cases an irregular but conspicuous zone which grades downwards into weakly mineralized granite.

As shown in figure 1, the level of erosion has resulted in a broad area of pervasive tungsten mineralization being exposed at the surface. Consequently, the open pit mine is characterized by a requirement to remove relatively small amounts of waste rock for each tonne of ore extracted.

While the ore reserves assumed in this case study (63 million tonnes averaging .170 percent WO_3) represent a reasonable expected scenario, deposits of this type are characteristically varied. The tungsten mineralization is comprised of both wolframite (iron-manganese tungstate) and scheelite (calcium tungstate).

Recoverable ore reserves: 63,000,000 tonnes averaging 0.170 percent WO_3

Capacity: 3,500,000 tonnes of ore per year

Mining method: open pit

Average stripping ratio: 1.1 tonne waste to 1 tonne ore

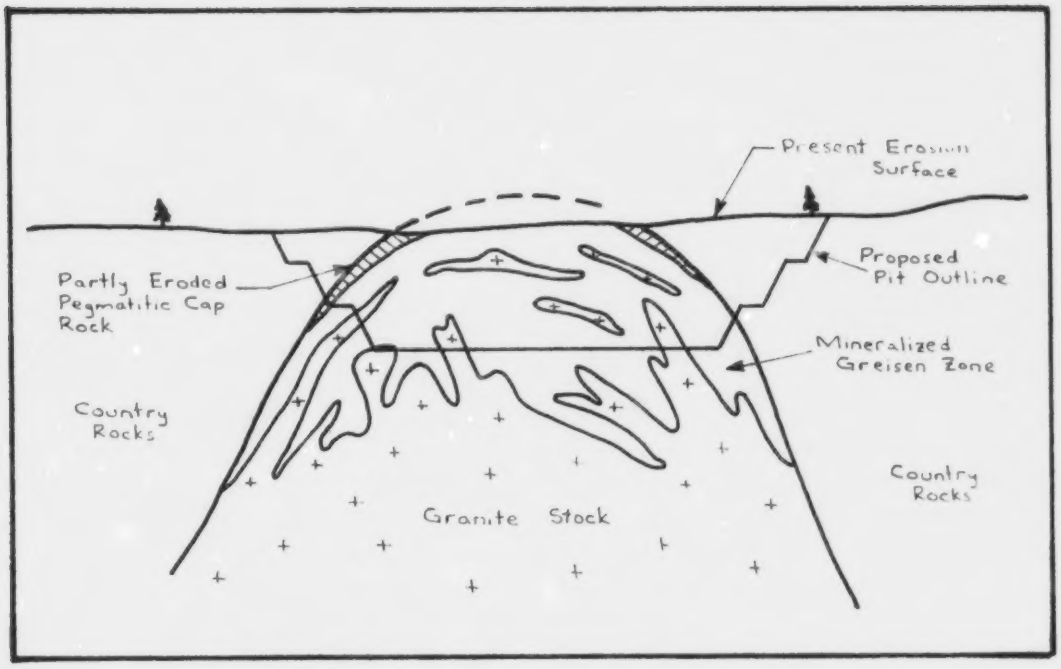

Figure 1. Idealized Section through Representative Tungsten Deposit

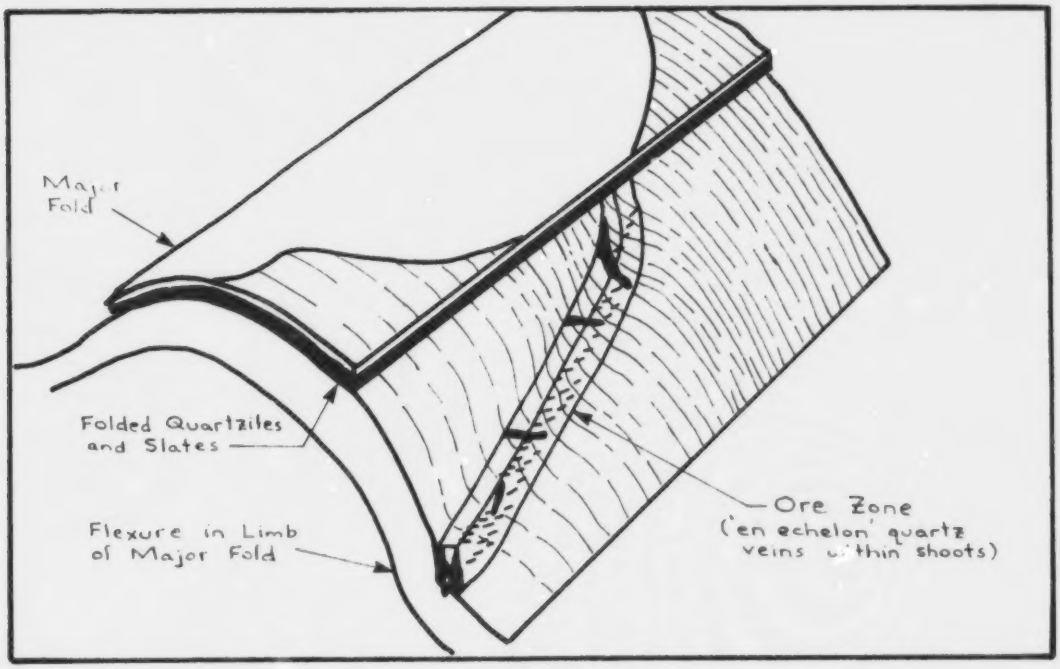

Figure 2. Schematic Isometric Projection of Representative Gold Deposit

Mineral processing flowsheet: crushing, grinding, and gravity separation to produce a high-grade WO_3 concentrate. Magnetic separation and flotation to increase recovery by producing a low-grade WO_3 concentrate.

Mill recovery factors:
65 percent in high-grade concentrate;
20 percent in low-grade concentrate.

Product specifications:
high-grade concentrate averaging 68 percent WO_3;
low-grade concentrate averaging 35 percent WO_3.

Preproduction development period: 2 years

Employment during construction: 742,000 person-hours (excluding infrastructure)

Employment during production: 265 persons

Electrical power consumption: 93.75 million kilowatt-hours per year

Fuel consumption: 1.5 million litres per year

Representative Gold Deposit

Geological Setting: Figure 2 provides a schematic isometric projection of the representative gold deposit. The host rocks for the deposit are a thick sequence of folded quartzites and slates. The gold is structurally controlled and occurs as 'en echelon' quartz veins within shoots which pitch at a low angle. The location of the shoots appears to be determined by flexures in the limbs of major folds, or fractures related to such structural features.

This type of gold deposit is typically small and difficult to evaluate. The ore zone in this particular case is assumed to average 10 metres in width by 40 metres vertically, over a length of 500 metres, pitching to an ultimate depth of 200 metres.

The gold ore contains a low concentration of sulphides. Most of the gold is free-milling, but arsenopyrite is found in considerable quantities in some veins and carries gold requiring cyanidation.

The ore reserves assumed for the representative deposit (650,000 tonnes at 9.40 grams per tonne Au) constitutes a reasonable expected target. However, this type of gold deposit is characteristically varied and there is no 'typical' deposit.

Recoverable ore reserves: 650,000 tonnes at 9.40 grams Au per tonne

Capacity: 65,000 tonnes of ore per year

Mining method: underground, irregular open stoping

Mineral processing flowsheet: crushing, grinding, cyanidation, carbon-in-pulp adsorption, stripping, electrowinning, and smelting.

Mill and smelter recovery factor: 95 percent

Product specification: impure bullion (doré)

Preproduction development period: 2 years

Employment during construction: 216,000 person-hours (excluding infrastructure)

Employment during production: 80 persons

Electrical power consumption: 5.18 million kilowatt-hours per year

Nova Scotia Base Cases

The foregoing general economic conditions and deposit-specific characteristics are combined to estimate revenues, preproduction capital costs, and production costs for the tungsten and gold projects in Nova Scotia. Economic criteria derived from these 'base case conditions' provide a standard for comparison.

The mine development opportunities in Nova Scotia are considered to be situated 10 kilometres from existing road, powerline, housing and townsite facilities.[11] Thus, it is assumed that 10 kilometres of new roads would have to be constructed, and a 10-kilometre electrical transmission

11. The tungsten deposit is assumed to be situated 50-120 kilometres west of Halifax. The gold deposit is hypothetically located northeast of Halifax in the Caribou gold district.

line built to service each of the mines. Furthermore, new houses would be required for senior mine managers; 10 units in the case of the tungsten project and 3 units in the case of the gold mine. The labour component of these infrastructure facilities (not included in the earlier estimates of person-hours of employment during mine development) is estimated to be 20 percent of the capital cost for road and transmission line requirements, and 30 percent in the case of houses. The same infrastructure assumptions are subsequently made for the more-accessible minesites in central Canada and western Canada.

Representative Tungsten Deposit

Concentrate market location: 50 percent of the high-grade and low-grade concentrates are shipped to European smelters, the remaining 50 percent being marketed in the state of New York.

Annual revenues: estimates of tungsten market price possibilities, exchange rates, the U.S. tariff, concentrate market locations, unit transportation costs, mine capacity, recoverable ore reserve grade, mill recovery factors, and concentrate specifications, are combined to evaluate the following annual minesite revenues.

Lower-limit prices: $32,638,000;

Expected prices: $54,680,000;

Upper-limit prices: $80,598,000.

Preproduction capital costs: estimated to total $133,477,000, with the following percentage breakdown.

Mine development	0.3
Mine plant and machinery	6.0
Mill facilities	76.0
Powerline	0.3
Road	0.9
Housing	0.6
Design and construction management	11.1
Working capital	4.8
Total	100.0

For evaluation purposes, it is assumed that working capital is required in the final preproduction year and that the other capital costs are spread evenly over the two development years.

For the calculation of non-profit taxes, it is further estimated that building materials account for $25.0 million of the total capital expenditures, and production equipment and machinery for $40.0 million.

Production costs: annual production costs, including operating costs and sustaining capital requirements, are estimated to total $26,573,000. The percentage breakdowns of these costs by stage of production and factor input is shown in table 3. For tax purposes, it is estimated that, of this total, sustaining capital accounts for $1,200,000, and materials and supplies in the mining stage for $3,168,000 per year.

Table 3

PRODUCTION COST BREAKDOWN: TUNGSTEN PROJECT, NOVA SCOTIA BASE CASE (percent)

Production Stage	Factor Input					
	Labour	Supplies[a]	Fuel	Power	Other	Total
Mining	10.6	15.1	2.4	-	-	28.1
Milling	20.1	23.0	0.4	13.4	-	56.9
General and administration	6.8	2.2	-	2.7	3.3	15.0
Total	37.5	40.3	2.8	16.1	3.3	100.0

[a] includes operating costs and sustaining capital.

Representative Gold Deposit

Annual revenues: evaluated by combining estimates of gold price projections, the all-inclusive transportation and marketing charge, mine capacity, recoverable ore reserve grade, and the mill recovery factor. The following annual revenues are calculated.

Lower-limit prices: $ 4,977,000

Expected prices: $ 7,931,000

Upper-limit prices: $12,192,000

Preproduction capital costs: estimated total of $11,199,000, consisting of the following percentage components.

Mine development	20.1
Mine plant and machinery	22.2
Mill facilities	29.7
Powerline	1.4
Road	6.3
Housing	2.3
Design and construction management	8.6
Working capital	9.4
Total	100.0

Once again, working capital is assumed to be required in the second year, the balance of the capital expenditures being evenly divided between the two preproduction years.

For tax purposes, it is estimated that building materials account for $1.5 million, and production equipment and machinery for $4.0 million of the total capital requirement.

Production costs: estimated to total $4,410,000 per year. Percentage breakdowns are given in table 4. It is further estimated for tax purposes, that sustaining capital represents $220,000 per year, and materials and supplies consumed in the mining stage account for $450,000 per year of this total.

Table 4

PRODUCTION COST BREAKDOWN: GOLD PROJECT, NOVA SCOTIA BASE CASE
(percent)

Production Stage	Factor Input				Total
	Labour	Supplies[a]	Power	Other	
Mining	45.4	14.3	2.4	-	62.1
Milling	12.7	8.9	4.0	-	25.6
General and administration	6.9	0.8	-	4.6	12.3
Total	65.0	24.0	6.4	4.6	100.0

Regional Economic Differences

The Nova Scotia base case conditions are now modified for regional economic differences in order to derive estimates for the more-accessible minesites in central Canada and western Canada. These adjustments are based on differential wage and salary rates, electrical power charges and, in the case of the tungsten project, concentrate market locations. The working capital requirement, assumed to provide for three months' operating costs, is adjusted accordingly.

Wage and Salary Rates

Wage and salary rate differentials are based on Statistics Canada data for average hourly earnings (including overtime) of salaried and hourly employees. The construction industry series is applied to labour costs during mine development while mining industry statistics are used for employment during production. The differentials are based on selected monthly statistics for 1983 and 1984. Construction and mining industry averages for the proportion of salaried and hourly workers are applied to derive weighted-average wage and salary rate differentials.

For the Nova Scotia base case, the rates applied are an average of Nova Scotia and New Brunswick. The Nova Scotia mining wage rates are strongly influenced by coal mining. For study purposes, it was considered realistic to adjust these rates upwards towards the New Brunswick statistics which are more characteristic of metal mining conditions.

Wage rates for central Canada represent averages of the Quebec, Ontario, and Manitoba series. The western Canada wage rates are based on statistics for British Columbia.

The statistical data utilized and the averaging process employed are detailed in appendix A. The resulting weighted average wage and salary rate differentials, relative to estimated Nova Scotia conditions, are as follows.

Mine development:

Central Canada +20 percent;

Western Canada +55 percent.

Mine production:

Central Canada +9 percent;

Western Canada +26 percent.

It is assumed that payments made on behalf of employees for programs sponsored by the company, and to federal and provincial government-mandated programs vary in proportion to these direct wage and salary differentials.[12]

We can find no evidence that these regional wage rate differences are attributable to differences in labour productivity. Consequently, the assumption is made that labour productivities for development and mining remain essentially uniform among regions and, therefore, the estimated wage rate variations represent real cost differences.

What, then, explains the striking wage and salary rate variations among regions? These differences appear to be attributable to the interaction of several factors including the regional labour environment, living costs, worker expectations, union militancy, tradition, labour competition, and alternative employment opportunities. For example, relatively high wage rates have always existed in British Columbia. Initially, this may have represented a 'remote area' premium to attract the required workforce. More recently, high wages in the construction industry are mainly the result of provincial certification and strong union power in controlling the number of new entrants. In British Columbia's mining industry, high wage rates, which appear to have been maintained through a particularly severe mining recession, are partly attributable to the premuims paid in competing labour markets; the forest products industry, and the energy sector in Alberta. In any case, the regional differences assessed are certainly significant. This looks like an interesting area for further research.

Unit Infrastructure Costs

The labour component of road, transmission line, housing and townsite costs (20 percent, 20 percent, and 30 percent respectively) is adjusted for the regional wage and salary rate differentials.

In western Canada, it is further assumed that the unit costs for road and powerline construction are 50 percent higher than in Nova Scotia to allow for the typically more severe topographic conditions.

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12. With the exception of workers' compensation payments which are considered in this study as one element of non-profit taxes.

Electrical Power Charges

Regional power cost estimates are based on 1984 provincial rate schedules in relation to the loading and demand requirements of the tungsten and gold projects. Charges for the base case assume Nova Scotia rates; power costs in central Canada represent a composite of Ontario and Manitoba rates; and estimates for western Canada once again reflect conditions in British Columbia. Thus, the following power cost differentials are estimated and applied relative to Nova Scotia base case conditions.

Central Canada:

Tungsten mine - 41 percent;

Gold mine - 36 percent.

Western Canada:

Tungsten mine - 34 percent;

Gold mine - 25 percent.

Tungsten Concentrate Market Location

Central Canada: assumes 50 percent of the high-grade and low-grade concentrates are shipped to smelters in Pennsylvania, the remaining 50 percent being sold in Ohio.

Western Canada: assumes 50 percent of the high-grade and low-grade concentrates are marketed in California, the remaining 50 percent being shipped to Japan.

Cash Flow Adjustments for Regional Conditions

The above regional concentrate market specifications are combined with the unit transportation costs given in table 2 to derive annual revenues for the tungsten mine in central Canada and western Canada. These results are compared with Nova Scotia base case conditions in table 5.

Table 5

ANNUAL MINESITE REVENUE FOR TUNGSTEN PROJECT
($ thousand)

Region	Lower Limit Prices	Expected Prices	Upper Limit Prices
Nova Scotia base case	32,638	54,680	80,598
Central Canada	31,928	53,865	79,721
Western Canada	32,333	54,374	80,293

Results show that minesite revenue is not very sensitive to regional differences between mine and market, reflecting the high unit value of the concentrate product. Also, the low minesite values for central Canada in relation to relatively low transportation costs (table 2) indicate that the tariff cost for tungsten concentrate entering the United States has a somewhat stronger effect then the transportation cost differentials among regions.

Annual revenue estimates for the gold project are not affected by deposit location.

With regard to cost estimates for the tungsten and gold mine opportunities, the following adjustments for regional economic conditions are made relative to the Nova Scotia base case:

- estimated construction industry wage and salary rate differentials are applied to the specifications for person-years of employment during mine development and to the labour component of the required infrastructure. Preproduction capital costs are varied accordingly;

- estimated mining industry wage and salary rate differentials are used to modify the labour component of production costs;

- estimated power cost differentials are applied to adjust production costs;

- working capital requirements, equivalent to three months' operating costs, are modified for the overall changes in production costs.

The resulting capital and production cost adjustments for central and western Canada, relative to Nova Scotia base case conditions, are detailed in table 6. The regional totals are summarized in table 7.

Table 6

REGIONAL COST DIFFERENCES RELATIVE TO NOVA SCOTIA BASE CASE: MORE-ACCESSIBLE MINESITES
($ thousand)

Cost Component	Tungsten Project		Gold Project	
	Central Canada	Western Canada	Central Canada	Western Canada
Annual production cost:				
Wages and salaries	+897	+2,591	+257	+745
Electrical power	-1,754	-1,455	-102	-70
Preproduction capital cost:				
Wages and salaries	+2,420	+6,655	+687	+1,890
Infrastructure	+100	+1,410	+45	+659
Working capital	+86	+584	+88	+218

Table 7

TOTAL PROJECT COSTS BY REGION: MORE-ACCESSIBLE MINESITES
($ thousand)

	Annual Production Cost	Preproduction Capital Cost
Tungsten project:		
Nova Scotia base case	26,573	133,477
Central Canada	25,716	136,083
Western Canada	27,709	142,126
Gold project:		
Nova Scotia base case	4,410	11,199
Central Canada	4,565	12,019
Western Canada	5,085	13,966

The evaluation generally assumes that a separate processing facility is required for the tungsten and gold projects. In the case of the small gold mine at the more-accessible sites in Nova Scotia, central Canada, and western Canada, the economic effects of the availability of an existing concentrating plant is also considered.

For this variant, a 500,000-tonne per year capacity is assumed for the existing mill, 15 kilometres distant from the small deposit. The capital and production cost estimates for the gold project are first reduced by the small mill costs. Then, the gold project is allocated a proportion of the capital costs for the existing concentrating plant based on relative capacities, and the average unit production cost associated with the larger-scale plant. The distance is used to compute a road haulage cost for transporting the ore from mine to mill.

Less-Accessible Minesite Costs

Within the central Canada and western Canada regions, the tungsten and gold projects are also evaluated at less-accessible sites. For illustrative purposes, the assumption is made that the less-accessible deposits are situated 50 kilometres rather than 10 kilometres from established road, transmission line, housing and townsite facilities. Daily bus commuting of the workforce from the existing townsite is considered. The regional cost estimates for the more-accessible minesites are modified to allow for:

- 40 additional kilometres of road construction;
- 40 additional kilometres of powerline;
- 5 more houses in the case of the tungsten project and 2 more houses for the gold mine;
- the direct cost of providing bus service for daily commuting estimated at $278,000 per year for the tungsten mine and $106,000 per year for the gold operation;
- 50 percent of the wage and salary cost associated with employee commuting time, assumed to total 2 hours per shift. Thus, based on a normal 8-hour shift, the time cost of daily commuting represents a 12.5 percent premium on the payroll cost at the more-accessible sites;
- associated increase in working capital requirements to provide the equivalent of three months' operating costs.

The resulting capital and production cost adjustments for the less-accessible deposit situations relative to the more-accessible regional sites are given in table 8. Comparative total project costs are summarized in table 9.

Table 8

COST PREMIUMS FOR LESS-ACCESSIBLE DEPOSIT SITES RELATIVE TO MORE-ACCESSIBLE REGIONAL CONDITIONS
($ thousand)

Cost Component	Tungsten Project		Gold Project	
	Central Canada	Western Canada	Central Canada	Western Canada
Annual production cost:				
Direct commuting	278	278	106	106
Commuting time	1,358	1,570	390	452
Preproduction capital cost:				
Housing	450	500	180	200
Road construction	4,800	7,680	2,920	4,680
Powerline	1,800	3,760	624	1,200
Working capital	409	462	124	139

Table 9

TOTAL PROJECT COSTS BY REGION AND DEPOSIT SITE
($ thousand)

	Annual Production Cost	Preproduction Capital Cost
Tungsten project		
Nova Scotia base case	26,573	133,477
Central Canada:		
More-accessible site	25,716	136,083
Less-accessible site	27,352	143,542
Western Canada:		
More-accessible site	27,709	142,126
Less-accessible site	29,557	154,528
Gold project		
Nova Scotia base case	4,410	11,199
Central Canada:		
More-accessible site	4,565	12,019
Less-accessible site	5,061	15,867
Western Canada:		
More-accessible site	5,085	13,966
Less-accessible site	5,643	20,185

Taxation Regimes

Based on the foregoing estimates for the assessment of before-tax cash flow, the direct effects of taxation on the representative tungsten and gold projects is evaluated. Thus, the tax systems existing in Canada at the beginning of 1985 are imposed to measure the after-tax incentive for investment; the level, structure and incidence of tax payments; and after-tax breakeven ore grades.

The federal corporate income tax, provincial corporate income tax, provincial mining tax, and provincial royalty systems applied in the study are detailed in appendix B. The individual project basis of taxation is generally assumed. The integrated company tax base is considered as a variant.

An outline of the five elements of non-profit tax considered follows.

Provincial Sales Tax

Provincial sales tax is estimated with respect to the purchase of building materials during the construction period, capital expenditures by the mine for production equipment and machinery, and the purchase of materials and supplies consumed in the production process. The rates applicable to the development and operation of mines are given in table 10.

Table 10

PROVINCIAL SALES TAX RATES
(percent)

Province	General Rate	Mine Building Materials	Mine Production Equipment and Machinery	Mine Production Materials and Supplies
Nova Scotia	10	10	4	4[a]
New Brunswick	10	10	exempt	10
Newfoundland	12	8	exempt	12
Quebec	9	9	exempt	exempt
Ontario	7	7	exempt	exempt
Manitoba	6	6	6	exempt
Saskatchewan	5	5	5	5
British Columbia	7	7	7	7

[a] applicable only to materials and supplies consumed up to the end of the mining stage.

Provincial Fuel Tax

Provincial fuel tax is considered for the open pit tungsten mine, assuming that fuel consumption takes the form of diesel fuel for mobile production equipment. For mining operations, the applicable fuel tax rates at January 1985 are shown in table 11.

Table 11

PROVINCIAL DIESEL FUEL TAX RATES
(cents per litre)

Province	General Rate	Mobile Mine Production Equipment
Nova Scotia	9.5	9.5
New Brunswick	9.7	exempt
Newfoundland	12.2	12.2
Quebec	11.25	exempt
Ontario	9.3	exempt
Manitoba	8.6	6.5
Saskatchewan	-	-
British Columbia	8.45	5.05

Corporation Capital Tax

The corporation capital tax base consists of equity capital, debt capital, and retained earnings, less depreciation as allowable for provincial corporate income tax purposes. The tax commences as soon as capital has been expended.

The annual rates which are applied to this capital base are:

Quebec	.45 percent
Ontario	.30 percent
Manitoba	.20 percent
Saskatchewan	.30 percent
British Columbia	.20 percent
Other provinces	-

Calculation of the corporation capital tax base involves financing and reinvestment assumptions, and an evaluation complexity which goes beyond the scope of the present study. Consequently, rather heroic tax base assumptions are made to simplify the calculation of corporation capital tax, enabling a uniform distribution of tax payments over the productive mine life. Our assumptions are as follows:

- all preproduction capital costs except for working capital, and all sustaining capital requirements are included in the 'total capital base';
- positive cash flows generated by the tungsten and gold mines are paid out to the investors;
- rather than evaluating and applying a declining capital base over the mine life, a constant base of 50 percent of the 'total capital base' is assumed throughout the productive life.

This simplified procedure hopefully produces realistic orders for the corporation capital tax estimates and meaningful tax differences among the provinces.

Workers' Compensation Rates

This government-mandated cost provides each province with a fund for the payment of compensation and other accident costs to industrial workers.

Assessment rates, expressed as a premium paid per year per $100 of total payroll, are set each year for various industry categories, including several mining classes. These rates (which for mines may include a separate silicosis component) apply up to a specified maximum total payroll per worker. The premiums, mining categories, and maximum payroll limits, all vary among the provinces.

The appropriate assessment rate and payroll limit apply to all workers at a particular mine. Except in Saskatchewan, the mining premiums also apply to workers involved in preproduction mine development. The published assessment rates, which may represent a typical or average premium, are initially applied to each mine and, then, specific mine premiums are adjusted year by year in relation to this general rate based on the mine's safety record.

For study purposes, 1985 workers' compensation rates are selected in each province for the mine classifications which most closely correspond to the tungsten and gold mines being evaluated. These premiums and the maximum total payroll they apply to are presented in table 12.

Table 12

WORKERS' COMPENSATION RATE ESTIMATES

Province	Maximum Total Payroll Applicable ($/employee/year)	Assessment Rate ($/$100 total payroll/year)	
		Tungsten	Gold Project
Nova Scotia	19,000	3.20	3.20
New Brunswick	27,500	1.90	1.90
Newfoundland	45,500	1.80	8.00
Quebec[a]	31,500	3.08	8.79
Ontario	26,800	4.44	12.05
Manitoba	28,000	3.14	3.14
Saskatchewan[b]	33,000	0.90	2.75
British Columbia	32,400	8.82	8.82

[a] 1984 rates
[b] rate of 3.75 applies to preproduction development work

'Total payroll' for purposes of assessing workers' compensation payments is equivalent to 'taxable benefits'. Thus, we have assumed that the total payroll is 90 percent of estimated before-tax wages and salaries. The average total payroll per employee is used to estimate the proportion of the total payroll which is below the maximum payroll and, therefore, subject to workers' compensation payments.

Property Taxes

Provincial and municipal property taxes are particularly difficult to estimate for a number of reasons. The determination of 'assessed value' is usually complex, arbitrary, and dynamic. There are a variety of property tax elements which may include school, hospital, water, municipal, regional and provincial levies. The definition of assessed value often varies among these components. The assessment rates may be a function of the area in which a mine is located and, particularly, depend on whether the minesite is within a municipality. In some cases, the generally applicable rates may be replaced by special provincial agreements.

Thus, the calculation of property taxes is complex. Furthermore, it is difficult to make provincial generalizations regarding typical property tax payments.

The study uses two approaches for the evaluation of property taxes within each province. First, the 'assessed value' for the tungsten and gold mines is estimated using a number of simplifying assumptions with regard to the application of provincial regulations. The property tax rates are then applied to these valuations to determine the annual property taxes payable. Second, a partial survey has been made of the actual property taxes paid in various provinces by operating mines of similar type and scale as the representative tungsten and gold projects. The study estimates adopted combine the results of the two approaches.

The property tax estimates used can only be regarded as providing a rough order-of-magnitude indication of the taxes which would typically be collected. There is a high degree of variability in property tax treatment within each province.[13]

Non-Profit Tax Estimates

Estimates of the five non-profit tax components considered by province assuming Nova Scotia base case conditions are presented in tables 13 and 14 for the tungsten and gold projects respectively. Similar sets of estimates are given in tables 15 and 16 for the variable region and minesite conditions.

Summaries of total undiscounted non-profit tax payments are shown in tables 17 and 18. For example, assuming Nova Scotia base case conditions (table 17), non-profit taxes for the tungsten project vary from $12.7 million for the less-accessible minesite in Ontario to $75.5 million in British Columbia. For the gold project, non-profit taxes range from $1.6 million in Manitoba to $5.3 million in British Columbia.

13. Such differences appear to be particularly pronounced in Ontario depending on whether or not a mine is within a municipal boundary. Consequently, in this case, our study makes the distinction that the more-accessible minesite is within a municipality but the less-accessible minesite is not.

Table 13

NON-PROFIT TAXES FOR NOVA SCOTIA BASE CASE CONDITIONS: TUNGSTEN PROJECT
($ thousand)

	Nova Scotia	New Brunswick	New-foundland	Quebec	Ontario[a]	Man-itoba	Sask-atchewan	British Columbia
Sales Tax:								
Preproduction Capital	4,100	2,500	2,000	2,250	1,750	3,900	3,250	4,550
Annual Sustaining Capital	57	-	-	-	-	72	60	84
Annual Operating Cost	127	951	1,141	-	-	-	475	666
Annual Fuel Tax	142	-	183	-	-	98	-	76
Annual Corporation Tax	-	-	-	335	223	149	223	149
Workers' Compensation Payments:								
Preproduction Capital	265	207	196	335	484	342	408	960
Annual Operating Cost	161	139	161	257	315	233	79	757
Annual Property Tax	800	850	775	160	1,675/45	675	72	2,158
Total Non-Profit Taxes								
Preproduction Capital	4,365	2,707	2,196	2,585	2,234	4,242	3,658	5,510
Annual Sustaining Capital	57	-	-	-	-	72	60	84
Annual Operating Cost	1,230	1,940	2,260	752	2,213/583	1,155	849	3,806

[a] more-accessible site/less-accessible site

Table 14

NON-PROFIT TAXES FOR NOVA SCOTIA BASE CASE CONDITIONS: GOLD PROJECT
($ thousand)

	Nova Scotia	New Brunswick	New-foundland	Quebec	Ontario[a]	Man-itoba	Sask-atchewan	British Columbia
Sales Tax:								
Preproduction Capital	310	150	120	135	105	330	275	385
Annual Sustaining Capital	8	-	-	-	-	13	11	15
Annual Operating Cost	18	106	127	-	-	-	53	74
Annual Fuel Tax	-	-	-	-	-	-	-	-
Annual Corporation Tax	-	-	-	27	18	12	18	12
Workers' Compensation Payments:								
Preproduction Capital	79	59	247	272	373	97	116	273
Annual Operating Cost	49	42	206	222	258	70	71	228
Annual Property Tax	68	32	145	6	57/2	25	8	132
Total Non-Profit Taxes								
Preproduction Capital	389	209	367	407	478	427	391	658
Annual Sustaining Capital	8	-	-	-	-	13	11	15
Annual Operating Cost	135	180	478	255	333/278	107	150	446

[a] more-accessible site/less-accessible site

Table 15

NON-PROFIT TAXES FOR VARIABLE REGION AND MINESITE CONDITIONS: TUNGSTEN PROJECT
($ thousand)

	Quebec		Ontario		Manitoba		Saskatchewan		British Columbia	
	CC-MA	CC-LA	CC-MA	CC-LA	CC-MA	CC-LA	CC-MA	CC-LA	WC-MA	WC-LA
Sales Tax:										
Preproduction Capital	2,250	2,250	1,750	1,750	3,900	3,900	3,250	3,250	4,550	4,550
Annual Sustaining Capital	-	-	-	-	72	72	60	60	84	84
Annual Operating Cost	-	-	-	-	-	-	475	475	666	666
Annual Fuel Tax	-	-	-	-	98	98	-	-	76	76
Annual Corporation Tax	340	356	227	237	151	158	227	237	157	169
Workers' Compensation Payments:										
Preproduction Capital	402	408	513	501	378	370	490	521	1,228	1,233
Annual Operating Cost	257	257	315	315	233	233	79	79	757	757
Annual Property Tax	163	172	1,709	48	689	726	74	78	2,298	2,499
Total Non-Profit Taxes										
Preproduction Capital	2,652	2,658	2,263	2,251	4,278	4,270	3,740	3,771	5,778	5,783
Annual Sustaining Capital	-	-	-	-	72	72	60	60	84	84
Annual Operating Cost	760	785	2,251	600	1,171	1,215	855	869	3,954	4,167

Note: non-profit taxes in Nova Scotia, New Brunswick, and Newfoundland remain the same since base case conditions apply (table 13).

CC: central Canada conditions
WC: western Canada conditions
MA: more-accessible minesite conditions
LA: less-accessible minesite conditions

Table 16

NON-PROFIT TAXES FOR VARIABLE REGION AND MINESITE CONDITIONS: GOLD PROJECT
($ thousand)

	Quebec		Ontario		Manitoba		Saskatchewan		British Columbia	
	CC-MA	CC-LA	CC-MA	CC-LA	CC-MA	CC-LA	CC-MA	CC-LA	WC-MA	WC-LA
Sales Tax:										
Preproduction Capital	135	135	105	105	330	330	275	275	385	385
Annual Sustaining Capital	-	-	-	-	13	13	11	11	15	15
Annual Operating Cost	-	-	-	-	-	-	53	53	74	74
Annual Fuel Tax	-	-	-	-	-	-	-	-	-	-
Annual Corporation Tax	29	37	19	25	13	17	19	25	15	21
Workers' Compensation Payments:										
Preproduction Capital	326	374	414	437	113	119	139	165	366	401
Annual Operating Cost	222	222	258	258	70	70	73	73	229	229
Annual Property Tax	7	9	61	3	27	35	9	11	165	238
Total Non-Profit Taxes										
Preproduction Capital	461	509	519	542	443	449	414	440	751	786
Annual Sustaining Capital	-	-	-	-	13	13	11	11	15	15
Annual Operating Cost	258	268	338	286	110	122	154	162	483	562

Note: non-profit taxes in Nova Scotia, New Brunswick, and Newfoundland remain the same since base case conditions apply (table 14).

CC: central Canada conditions
WC: western Canada conditions
MA: more-accessible minesite conditions
LA: less-accessible minesite conditions

Table 17

TOTAL UNDISCOUNTED NON-PROFIT TAXES: NOVA SCOTIA BASE CASE CONDITIONS
($ thousand)

	Tungsten Project	Gold Project
Nova Scotia	27,531	1,819
New Brunswick	37,627	2,009
Newfoundland	42,876	5,147
Quebec	16,121	2,957
Ontario:		
More-accessible site	42,068	3,808
Less-accessible site	12,728	3,258
Manitoba	26,328	1,627
Saskatchewan	20,020	2,001
British Columbia	75,530	5,268

Table 18

TOTAL UNDISCOUNTED NON-PROFIT TAXES: VARIABLE REGION AND MINESITE CONDITIONS

	Tungsten Project	Gold Project
Nova Scotia	27,531	1,819
New Brunswick	37,627	2,009
Newfoundland	42,876	5,147
Quebec:		
More-accessible site	16,332	3,041
Less-accessible site	16,788	3,189
Ontario:		
More-accessible site	42,781	3,899
Less-accessible site	13,051	3,402
Manitoba:		
More-accessible site	26,652	1,673
Less-accessible site	27,436	1,799
Saskatchewan:		
More-accessible site	20,210	2,064
Less-accessible site	20,493	2,170
British Columbia:		
More-accessible site	78,462	5,731
Less-accessible site	82,301	6,556

Graphical portrayals of the estimates presented in tables 13-14 and 17 for Nova Scotia base case conditions are given in figures 3 and 4, showing provincial variations in the level and components of total non-profit taxes.

It is clear that non-profit taxes are not only sizeable, but also highly variable among provinces.

Critique

A number of improvements could be made to the completeness and reliability of the non-profit tax estimates, including:

1. The inclusion of federal sales tax. The general rate is 10 percent. For the development and operation of mines, a rate of 6 percent applies to the purchase of building materials during construction. Expenditures for production equipment and machinery, and materials and supplies consumed in the production process are exempt.

2. The inclusion of sales tax on the purchase of electrical power. The applicable rates are 12 percent in Newfoundland, 6 percent in Manitoba, 5 percent in Saskatchewan, and 7 percent in British Columbia. Mining operations in other provinces are essentially exempt.

3. More reliable estimates of property taxes, calling on help from provincial directors of property assessment. A realistic range of property tax payments could usefully be assessed for each provincial situation.

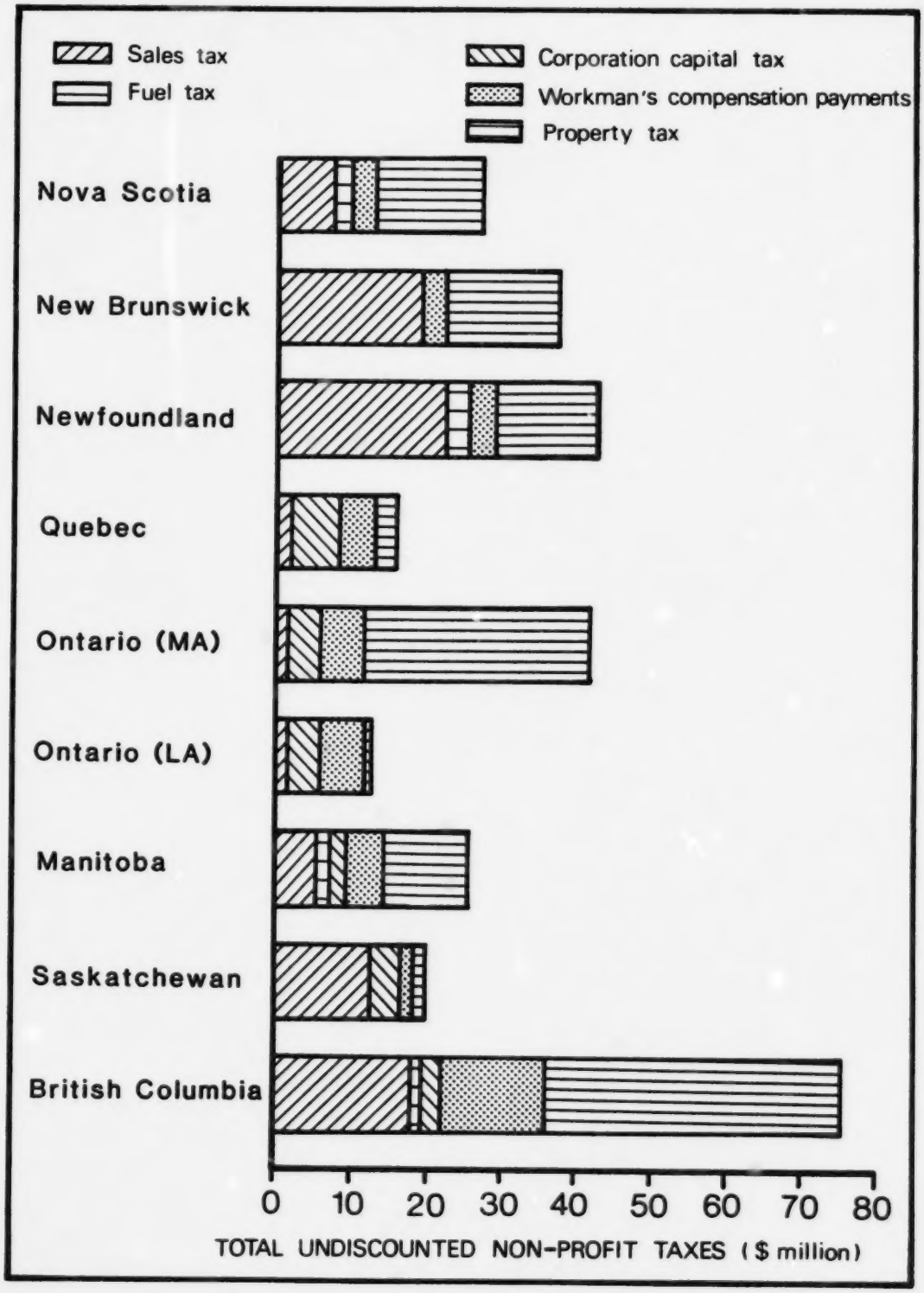

Figure 3. Total Non-Profit Tax Payments and Components: Tungsten Project, Nova Scotia Base Case Conditions

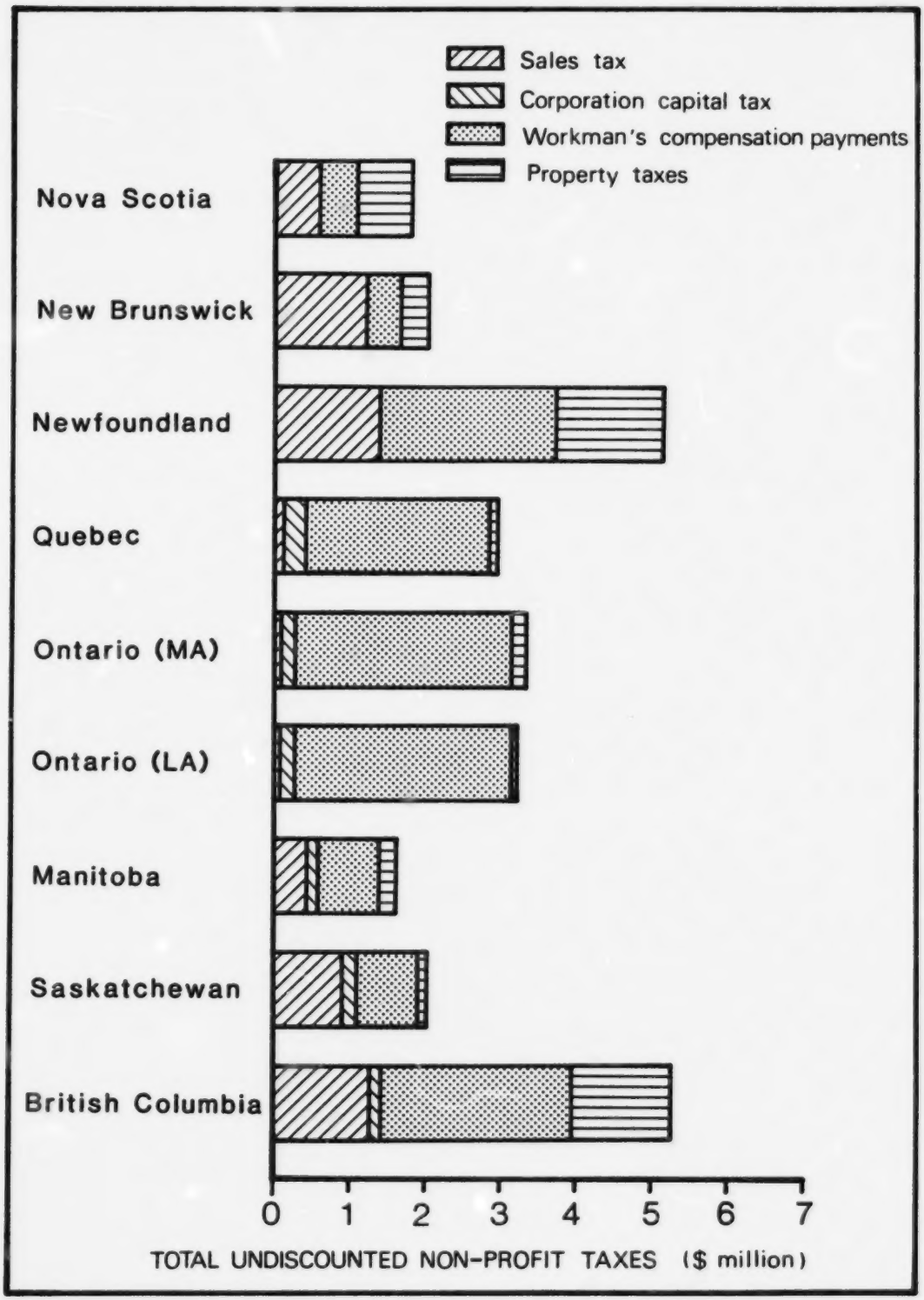

Figure 4. Total Non-Profit Tax Payments and Components: Gold Project, Nova Scotia Base Case Conditions

4. BEFORE-TAX EFFECTS OF LOCATION

In this first stage of evaluation, locational effects are analyzed on a before-tax basis. The before-tax economic indicators reflect the productive capability of the tungsten and gold deposits and represent what is available for sharing between company and government prior to taxation considerations.

Nova Scotia Base Cases

The base case conditions, to which other results are compared, are: tungsten and gold projects evaluated in Nova Scotia using a 10-percent cost of capital, expected price projections, and stand-alone processing facilities.

The resulting cash flow distributions for these base case projects are shown in figure 5. Economic indicators, derived from these distributions, are presented in table 19.

Under these conditions, both projects are shown to be economically viable, offering reasonable prospects for wealth creation.

Table 19

BEFORE-TAX ECONOMIC INDICATORS FOR NOVA SCOTIA BASE CASE CONDITIONS

	Total Revenue ($ million)	Undiscounted Cash Flow ($ million)	Net Present Value at 10% ($ million)	Rate of Return (percent)
Tungsten project	984.2	378.7	75.9	18.5
Gold project	79.3	25.1	8.5	25.5

Cost-of-Capital Variants

A constant money cost of capital of 10 percent is used in the base case. To analyze the sensitivity of results to the cost of capital, the before-tax net present values of the tungsten and gold projects are also evaluated for 5 percent and 15 percent rates. Results are compared in table 20 and figure 6.

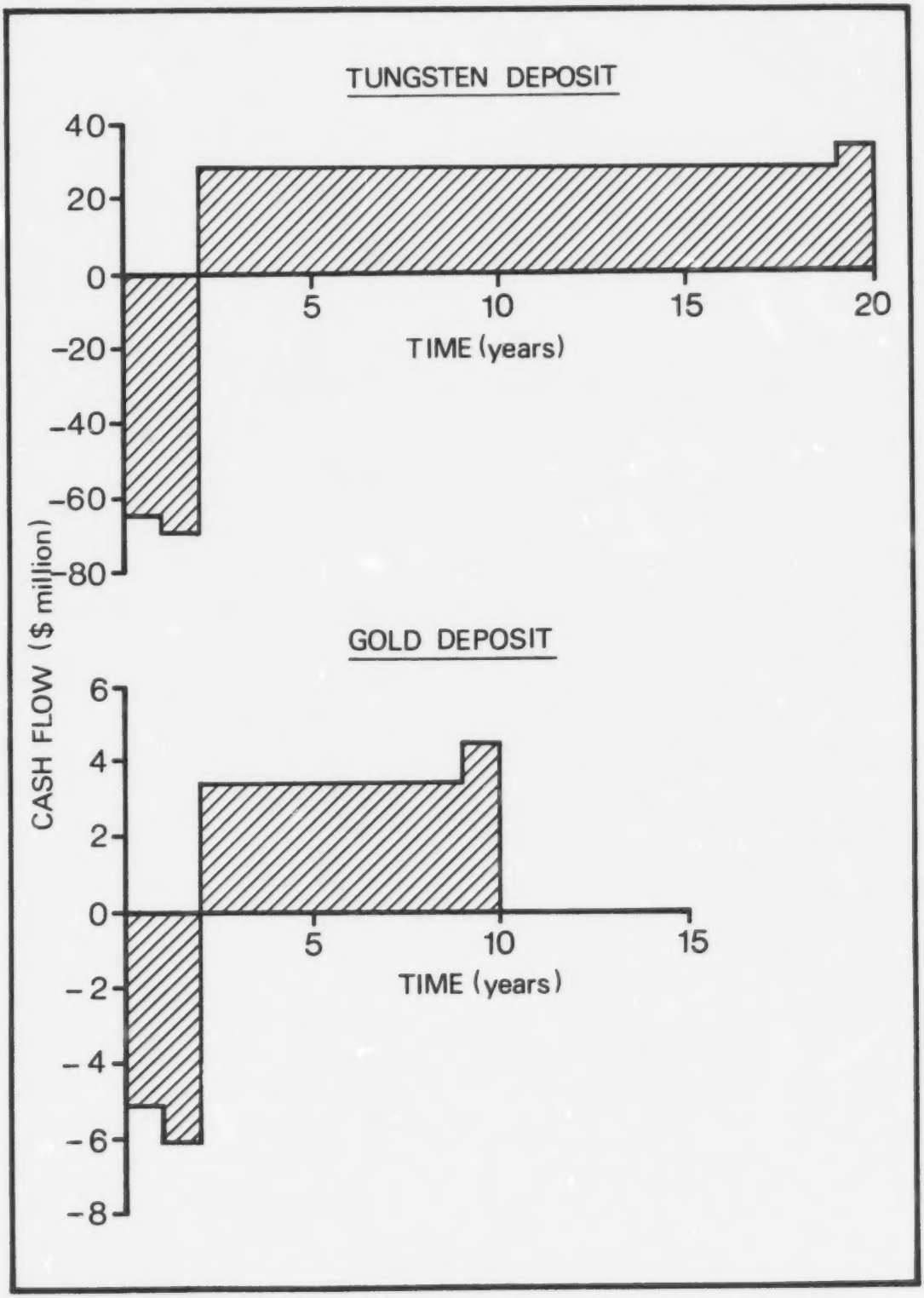

Figure 5. Before-Tax Cash Flow Distributions: Nova Scotia Base Case Conditions

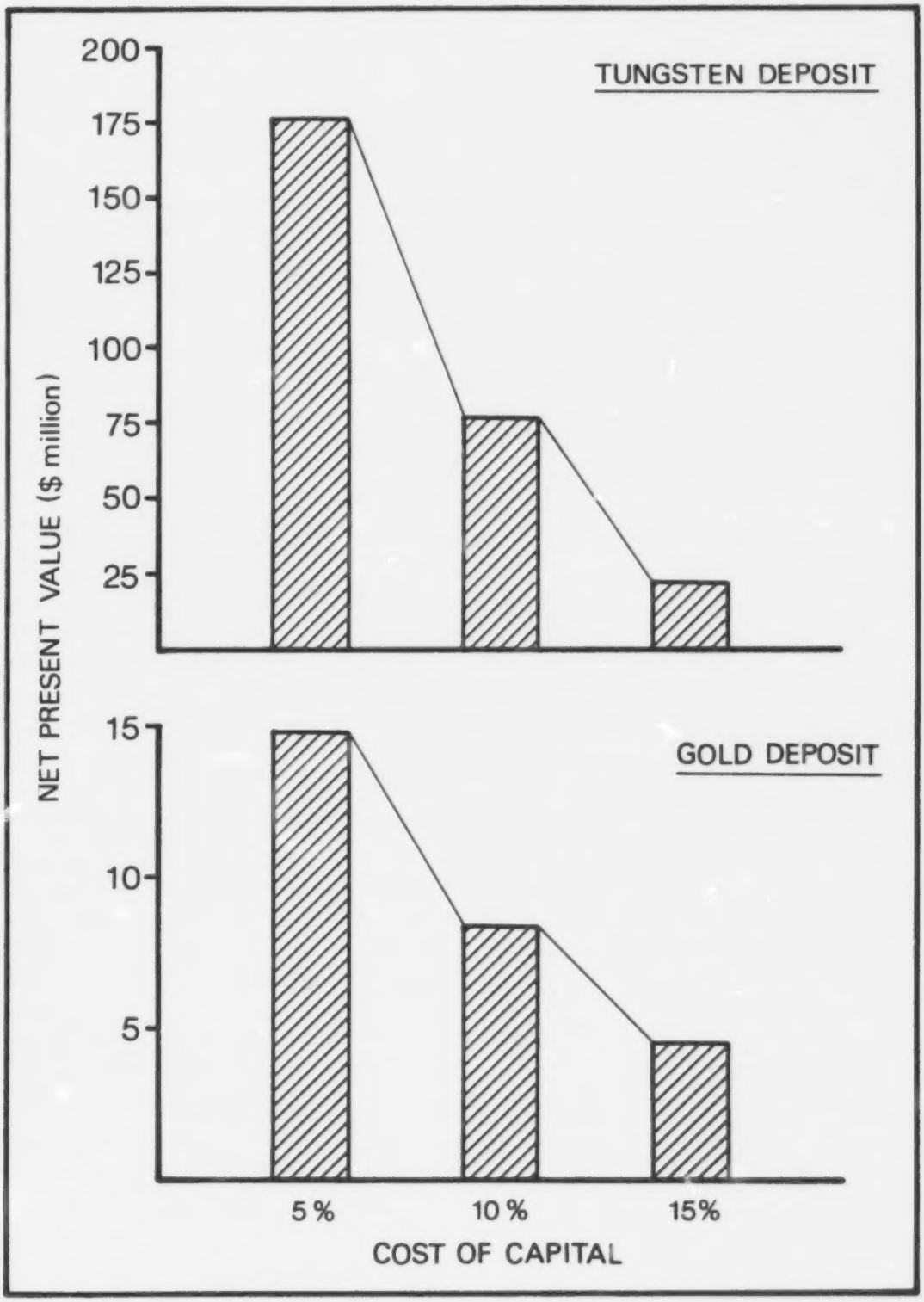

Figure 6. Sensitivity of Before-Tax Net Present Value to the Cost of Capital

Table 20

SENSITIVITY OF BEFORE-TAX NET PRESENT VALUE TO THE COST OF CAPITAL

Cost of Capital	Net Present Value ($ million)	Rate of Return (percent)
Tungsten project:		
5 percent	176.4	18.5
10 percent	75.9	18.5
15 percent	22.5	18.5
Gold Project:		
5 percent	14.9	25.5
10 percent	8.5	25.5
15 percent	4.5	25.5

Increasing the cost of capital discount rate is shown to have a strong effect on reducing the net present value of these projects. Since the time distribution of positive cash flows occurs further into the future than the time distribution of negative cash flows, heavier discounting resulting from a higher cost of capital rate reduces the discounted positive cash flows more than the discounted negative cash flows. Thus, the net present value is reduced.

The economic viability of the tungsten project is much more sensitive to the cost of capital rate than the gold case, the net present value being reduced by a factor of almost 8 times as compared to about 3 times for the gold project as the discount rate is increased through the specified range. This reflects the relatively strong discounting effects on positive cash flows in years 11-20 (see figure 5).

Notably, both projects remain economically viable through the cost of capital range examined here.

Metal Price Variants

The metal price projections used in the base case represent uncertain 'expected value' estimates. The sensitivity of before-tax economic indicators to possible variations in metal prices within the lower-limit to upper-limit range (table 1) is examined here.

Table 21 shows the effect of these metal price variants for the tungsten and gold projects on total minesite revenue, undiscounted cash flow over mine life, net present value at 10 percent, and rate of return. The impact of metal prices on rate of return is further illustrated in figure 7 in relation to the possible cost of capital hurdle rates considered in the previous section.

Table 21

SENSITIVITY OF BEFORE-TAX ECONOMIC INDICATORS TO METAL PRICES

	Total Revenue ($ million)	Undiscounted Cash Flow ($ million)	Net Present Value at 10% ($ million)	Rate of Return (percent)
Tungsten project:				
Lower-limit prices	587.5	-18.0	-73.5	-1.3
Expected prices	984.2	378.7	75.9	18.5
Upper-limit prices	1,450.8	845.3	251.6	34.6
Gold project:				
Lower-limit prices	49.8	-4.5	-6.5	-7.0
Expected prices	79.3	25.1	8.5	25.5
Upper-limit prices	121.9	67.7	30.2	55.0

These results clearly show the high degree of sensitivity of project viability to future metal price conditions. The tungsten and gold mine development opportunities are both decidedly uneconomic at lower-limit prices. As metal price levels increase, there is a dramatic improvement in project economics. Both opportunities are reasonably economic at expected prices (base case conditions) and, at upper-limit prices, would create substantial amounts of new wealth.

Regional Variants

The tungsten and gold deposits are now hypothetically relocated to sites in central Canada and western Canada. General economic conditions and

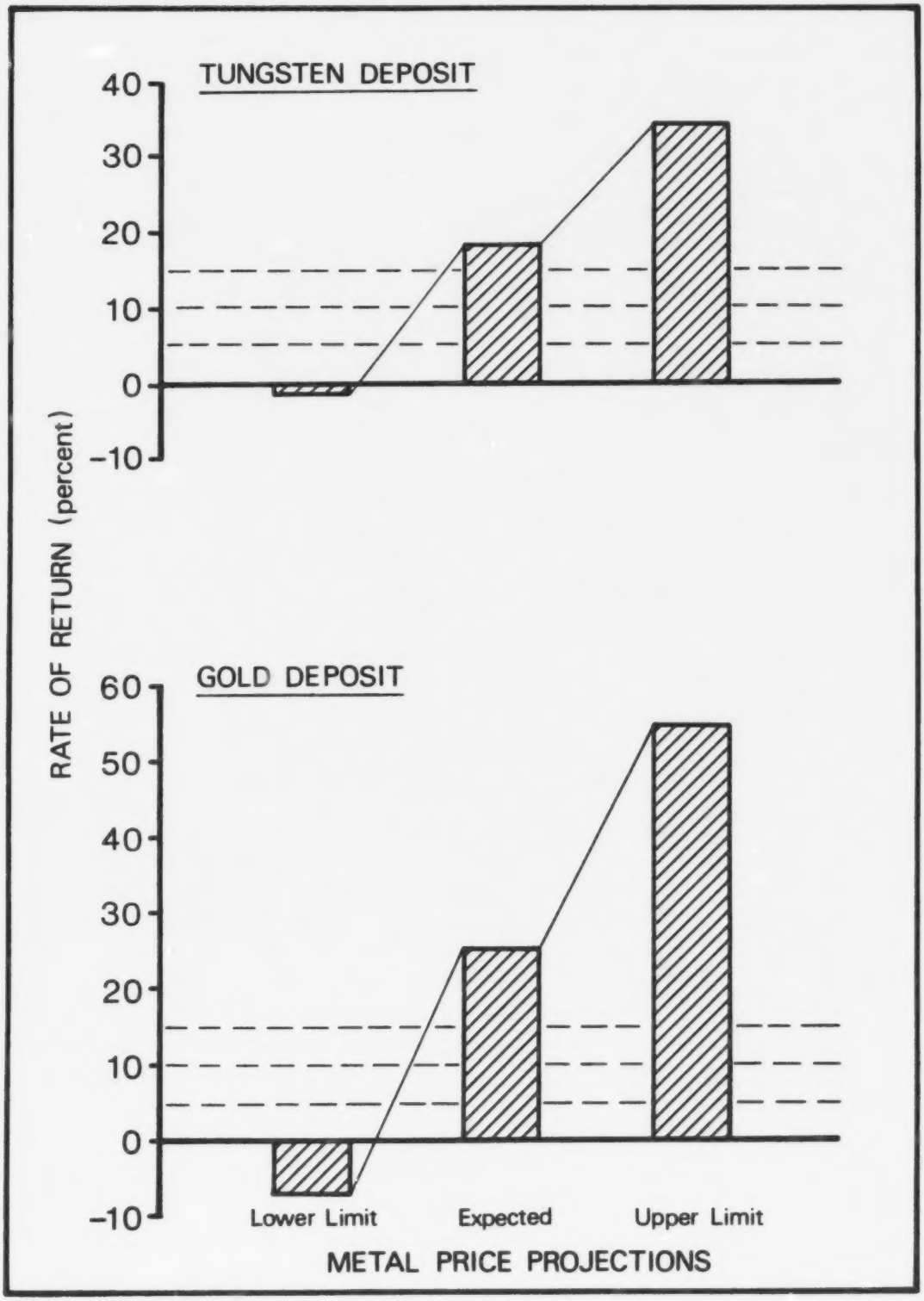

Figure 7. Sensitivity of Before-Tax Rate of Return to Metal Prices

deposit-specific characteristics are held constant. 'More-accessible' infrastructure conditions, similar to the Nova Scotia base case, are assumed.

Modifications are made to the revenue, capital cost, and operating cost estimates to allow for anticipated differences in regional economic conditions. Results for central Canada and western Canada are compared with the Nova Scotia base case in table 22.

Table 22

BEFORE-TAX ECONOMIC INDICATORS FOR REGIONAL VARIANTS

	Total Revenue ($ million)	Undiscounted Cash Flow ($ million)	Net Present Value at 10% ($ million)	Rate of Return (percent)
Tungsten project:				
Nova Scotia base case	984.2	378.7	75.9	18.5
Central Canada	969.6	377.3	74.0	18.1
Western Canada	978.7	345.0	58.8	16.3
Gold deposit:				
Nova Scotia base case	79.3	25.1	8.5	25.5
Central Canada	79.3	22.8	7.1	22.3
Western Canada	79.3	15.8	2.8	14.5

Tungsten Project

The variation in total minesite revenue shown among regions reflects differences in assumed market locations, and unit transportation costs. The lower revenue realized from the tungsten mine in central Canada indicates that the unit transportation cost advantage in this region is outweighted by higher tariff payments into the United States market.

The tungsten project in central Canada is marginally less attractive than the Nova Scotia base case. Thus, the lower sales revenue realized and higher wage and salary rates paid more than offset the power cost advantage of this region.

Significantly less favourable economic results for the tungsten project in western Canada mainly reflect the significant wage and salary rate premiums which would have to be paid to construct and operate a mine in that region.

Gold Project

The general relationship among the gold project results shown in table 22 is the same as for the tungsten project but the regional differences are more substantial. The labour-intensive nature of the small underground gold mine coupled with the regional wage and salary rate variations, tend to increase the relative attractiveness of the Nova Scotia base case. The difference between the Nova Scotia and western Canada results is particularly striking.

Deposit Accessibility Variants

At this time, 'less-accessible' sites are considered for the tungsten and gold deposits within the central Canada and western Canada regions, 50 kilometres rather than 10 kilometres from existing infrastructure. Appropriate modifications are made to the cash flow estimates and the mine development opportunities are re-evaluated. Results are compared with those previously shown for the more-accessible minesites in Nova Scotia, central Canada, and western Canada.

Economic indicators for the tungsten project are presented in table 23. The higher infrastructure and commuting costs associated with the less-accessible sites significantly reduce the before-tax economic indicators. The differences between sites within central and western Canada appear to be of the same order.

Table 24 shows the before-tax economic indicators for the gold project. Here again, the effects of deposit accessibility are more substantial due to the relatively small and labour-intensive nature of the project. Also, the economic differences between sites in western Canada are shown to be greater than in central Canada.

Table 23

SENSITIVITY OF BEFORE-TAX ECONOMIC INDICATORS FOR TUNGSTEN PROJECT TO ACCESSIBILITY OF DEPOSIT SITE

	Undiscounted Cash Flow ($ million)	Net Present Value at 10% ($ million)	Rate of Return (percent)
Nova Scotia base case	378.7	75.9	18.5
Central Canada:			
More-accessible site	377.3	74.0	18.1
Less-accessible site	340.7	56.5	16.0
Western Canada:			
More-accessible site	345.0	58.8	16.3
Less-accessible site	299.7	35.6	13.6

Table 24

SENSITIVITY OF BEFORE-TAX ECONOMIC INDICATORS FOR GOLD PROJECT TO ACCESSIBILITY OF DEPOSIT SITE

	Undiscounted Cash Flow ($ million)	Net Present Value at 10% ($ million)	Rate of Return (percent)
Nova Scotia base case	25.1	8.5	25.5
Central Canada:			
More-accessible site	22.8	7.1	22.3
Less-accessible site	14.1	1.3	11.8
Western Canada:			
More-accessible site	15.8	2.8	14.5
Less-accessible site	4.1	-5.4	3.1

The more-accessible deposit sites considered in Nova Scotia may be regarded as typical. However, even the less-accessible sites assumed in central Canada and western Canada may be considered favourable in relation to the low density of infrastructure existing in some areas of more favourable undiscovered mineral potential. This argument, viewed in the context of results presented in tables 23-24, tends to reinforce the before-tax favourability of a Nova Scotia location for mineral exploration and development.

To this point, the evaluation has assumed that a separate processing facility is required to treat the tungsten and gold ores. The economic effects of the availability of an existing regional mill for the small gold deposit at the more-accessible sites are presented in table 25. The regional processing opportunity is shown to have a strong impact on improving the economic attractiveness of the gold project.

Table 25

EFFECT OF REGIONAL MILL OPPORTUNITY ON BEFORE-TAX ECONOMIC INDICATORS FOR GOLD DEPOSIT AT MORE-ACCESSIBLE SITES

	Undiscounted Cash Flow ($ million)	Net Present Value at 10% ($ million)	Rate of Return (percent)
Nova Scotia:			
Separate mill	25.1	8.5	25.5
Regional mill	31.1	12.2	33.9
Central Canada:			
Separate mill	22.8	7.1	22.3
Regional mill	29.5	11.1	31.0
Western Canada:			
Separate mill	15.8	2.8	14.5
Regional mill	24.5	8.0	24.2

Breakeven Ore Grades

Finally, the before-tax effects of location are expressed in another way. Instead of assuming a deposit grade and determining various economic indicators, a minimum acceptable economic result is specified (generally, a 10-percent rate of return) and the breakeven ore grade yielding this return is assessed.

Breakeven recoverable tungsten and gold grades for the range of variants considered in this chapter are presented in table 26. Figure 8 further illustrates these breakeven values as functions of cost of capital and metal price.

Table 26

BEFORE-TAX BREAKEVEN ORE GRADES

	Tungsten Deposit (percent WO_3)	Gold Deposit (grams Au per tonne)
Nova Scotia base case	.135	7.41
Cost-of-capital variants:		
5 percent	.118	6.89
15 percent	.155	7.99
Metal price variants:		
Lower limit	.226	11.80
Upper limit	.092	4.82
Regional variants:		
Central Canada	.136	7.75
Western Canada	.143	8.75
Less-accessible deposit sites:		
Central Canada	.144	9.11
Western Canada	.154	10.66
Regional mill opportunity: (gold project only):		
Nova Scotia	-	6.56
Central Canada	-	6.81
Western Canada	-	7.52

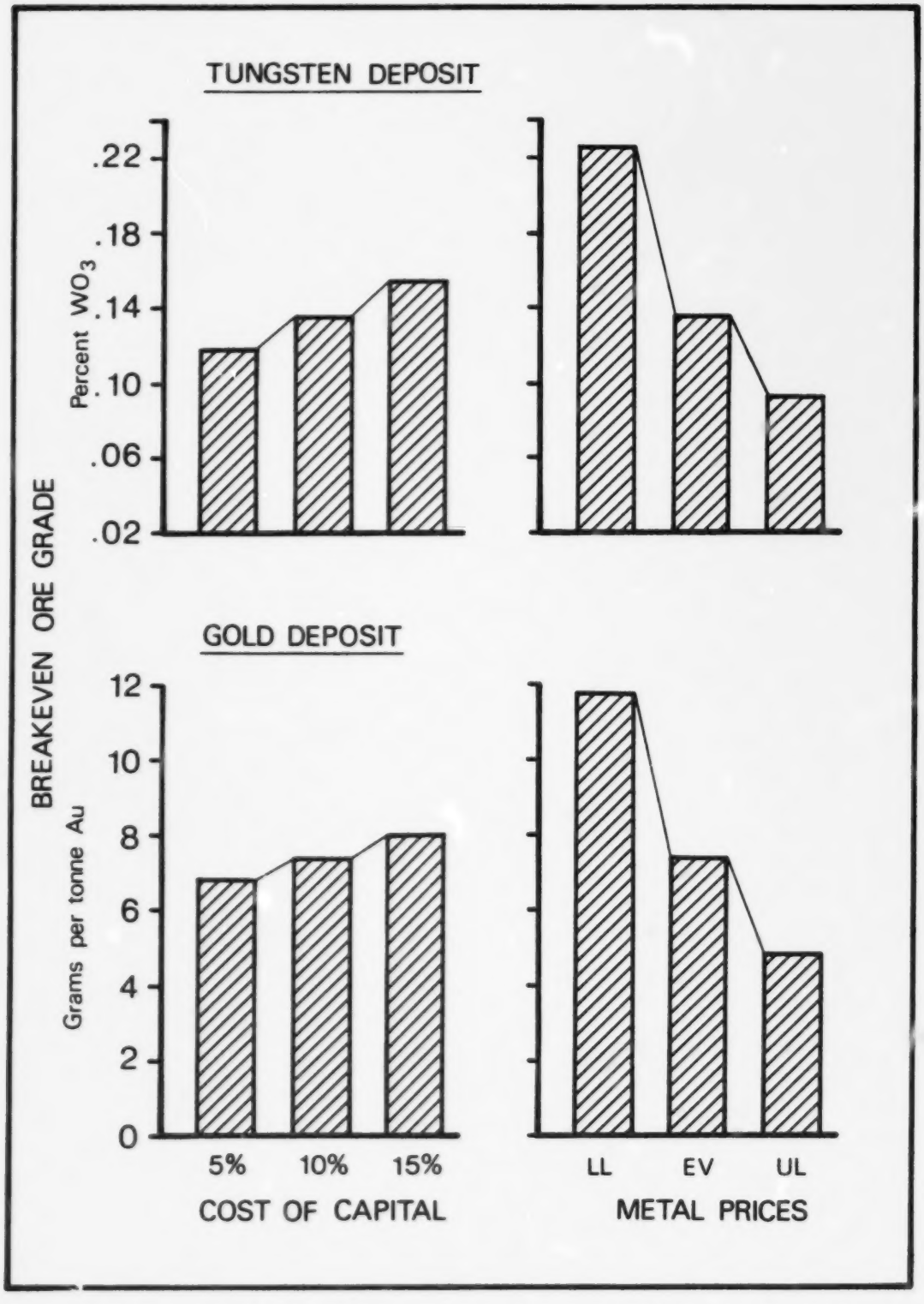

Figure 8. Sensitivity of Before-Tax Breakeven Ore Grades to Cost of Capital and Metal Prices

The before-tax breakeven ore grades are shown to vary widely, paralleling the differences in economic indicators presented earlier in the chapter. For example, in the case of the gold deposit, the grade required to yield a 10-percent rate of return varies from 7.4 grams per tonne in Nova Scotia to 10.7 grams per tonne at the less-accessible minesite in western Canada. In Nova Scotia, the minimum acceptable grade increases from 4.8 grams per tonne at upper-limit prices to 11.8 grams per tonne at lower-limit prices.

5. EFFECTS OF TAXATION AMONG PROVINCES

In order to compare the economic effects of taxation among provinces, all before-tax conditions are held constant. The Nova Scotia base cases are selected to provide this common standard. Thus, differences in after-tax results solely reflect differences in tax policies as applied to the representative tungsten and gold projects.

The evaluation of taxation effects, except where otherwise noted, assumes an individual project basis of taxation.

After-Tax Investment Incentive

The after-tax investment incentive to the mining company is measured here by after-tax net present value and rate of return indicators. The higher these after-tax economic indicators, the greater will be the incentive to invest. A positive investment incentive is considered to exist as long as the after-tax net present value remains positive or, in other words, as long as the after-tax rate of return on investment exceeds the cost of capital.

As will be seen, using these investment criteria, contradictory results may arise in the ranking of provinces whereby a project in one province may yield a higher after-tax net present value but a lower after-tax rate of return than in another province. Such contradictory results occur because of the difference in time value embodied in the two criteria which discount cash flows at the cost of capital rate and at the rate of return respectively. For projects which are economic after tax, a taxation regime which results in a higher after-tax net present value but a lower after-tax rate of return will generally embody a time distribution of tax payments which is relatively strongly weighted towards the earlier years of project life.

To illustrate the derivation of after-tax economic indicators, the effect of the tax system existing in Nova Scotia on the time distribution of cash flows for the tungsten and gold projects is shown in figure 9. The level of tax payments increase from the earlier to later years of mine production. Tax relief in the earlier years is mainly attributable to the investment tax credit for income tax, and the accelerated write-off of capital for both income and Nova Scotia mining tax purposes. Non-profit taxes, net of income and mining tax credits, are shown in this case to be quite modest.

The cash flow distributions presented in figure 9 are applied to determine the after-tax measures of investment incentive. Results for the

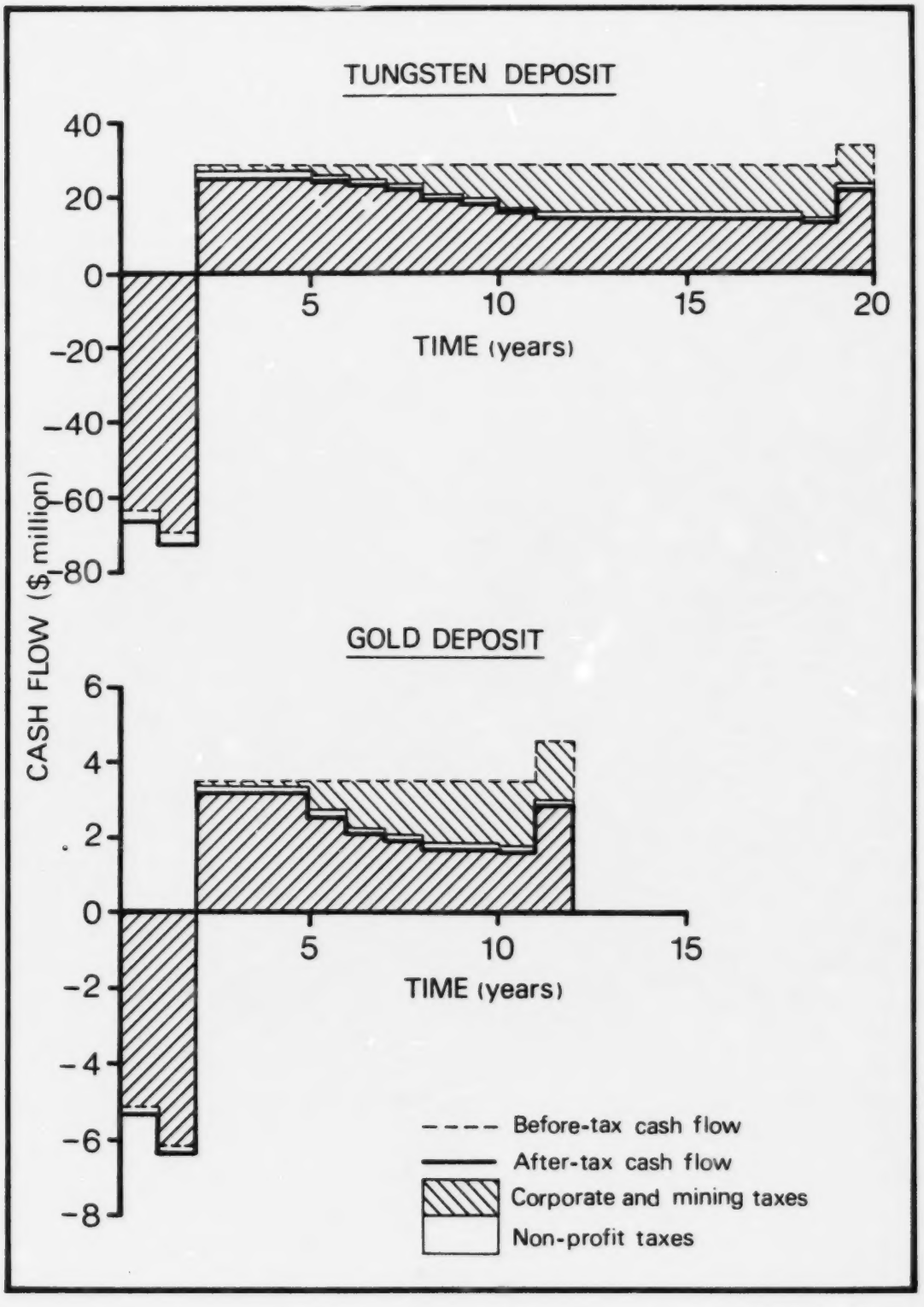

Figure 9. After-Tax Cash Flow Distributions: Base Case Conditions, Nova Scotia Taxation Regime

tax regime in Nova Scotia are presented in table 27 together with comparable results for the other seven provinces considered. In all cases, the after-tax indicators are substantially below the before-tax project values, differences reflecting the level of taxation payments.

For the tungsten project, the taxation systems in Nova Scotia, Saskatchewan, and Ontario (less-accessible site) provide the best investment incentive. At the other extreme, the British Columbia, Ontario (more-accessible site), and Newfoundland tax systems are the least favourable. In fact, the tax system in British Columbia drives after-tax values right down to the economic margin.

Table 27

EFFECT OF TAXATION ON ECONOMIC INDICATORS: NOVA SCOTIA BASE CASE CONDITIONS

	Tungsten Project		Gold Project	
	Net Present Value at 10% ($ million)	Rate of Return (percent)	Net Present Value at 10% ($ milion)	Rate of Return (percent)
Before-tax results	75.9	18.5	8.5	25.5
After-tax results				
Taxation regime:				
Nova Scotia	25.0	13.3	3.0	16.7
New Brunswick	17.3	12.5	2.8	16.6
Newfoundland	13.0	11.8	1.6	13.7
Quebec	21.5	13.1	3.3	17.3
Ontario:				
More-accessible site	17.0	12.5	2.4	15.5
Less-accessible site	23.1	13.3	2.6	15.8
Manitoba	19.5	12.8	2.8	16.4
Saskatchewan	23.6	13.3	3.1	16.7
British Columbia	0.0	10.0	1.2	12.7

Metal Price Variants

The results presented in table 27 are based on expected metal price projections. In this section, the sensitivity of after-tax investment incentive among provinces to the lower-limit and upper-limit price variants is examined. Economic indicators for the open pit tungsten project are shown in table 28, and for the underground gold project in table 29.

Table 28

SENSITIVITY OF AFTER-TAX ECONOMIC INDICATORS TO METAL PRICES: TUNGSTEN PROJECT, NOVA SCOTIA BASE CASE CONDITIONS

	Net Present Value at 10% ($ million)		Rate of Return (percent)	
	Lower Limit Prices	Upper Limit Prices	Lower Limit Prices	Upper Limit Prices
Before-tax results	-73.5	251.6	-1.3	34.6
After-tax results				
Taxation regime:				
Nova Scotia	-90.4	115.3	-4.6	24.9
New Brunswick	-90.4	107.6	-4.9	24.8
Newfoundland	-90.8	101.2	-5.1	23.3
Quebec	-80.8	107.2	-2.6	24.8
Ontario:				
More-accessible site	-90.5	97.7	-5.0	23.8
Less-accessible site	-79.7	101.7	-2.5	24.3
Manitoba	-85.5	107.4	-3.4	24.5
Saskatchewan	-83.1	118.9	-3.0	25.3
British Columbia	-105.5	83.9	-9.0	21.7

Table 29

SENSITIVITY OF AFTER-TAX ECONOMIC INDICATORS TO METAL PRICES: GOLD PROJECT, NOVA SCOTIA BASE CASE CONDITIONS

	Net Present Value at 10% ($ million)		Rate of Return (percent)	
	Lower Limit Prices	Upper Limit Prices	Lower Limit Prices	Upper Limit Prices
Before-tax results	-6.5	30.2	-7.0	55.0
After-tax results				
Taxation regime:				
Nova Scotia	-8.0	14.4	-12.2	38.7
New Brunswick	-7.8	13.6	-12.0	38.6
Newfoundland	-9.2	12.1	-17.9	34.4
Quebec	-8.1	15.4	-12.5	39.7
Ontario:				
More-accessible site	-8.6	13.1	-14.3	36.0
Less-accessible site	-8.3	13.2	-13.0	36.3
Manitoba	-7.4	13.4	-9.7	37.1
Saskatchewan	-7.6	14.6	-10.5	38.5
British Columbia	-9.4	11.2	-17.6	33.6

At lower-limit prices, in all taxation jurisdictions considered, both projects become even more uneconomic after tax than on a before-tax basis. While taxation sharply reduces the incentive to invest at upper-limit prices, both projects remain decidedly economic throughout.

In terms of competitive ranking among the provinces, the Ontario (less-accessible site), Quebec, and Saskatchewan tax systems inflict the least damage on the (un)economic indicators for the tungsten project at lower-limit prices. Considering upper-limit price possibilities, the Saskatchewan and Nova Scotia taxation regimes provide the most investment incentive.

For the gold mine development opportunity, at lower-limit prices, taxation policies existing in Manitoba, Saskatchewan, and New Brunswick provide the least burden. Assuming upper-limit price conditions, the Quebec, Saskatchewan, Nova Scotia, and New Brunswick tax systems provide the most encouragement for investment.

In all cases, taxation in British Columbia clearly exhibits the most punitive effects on the after-tax investment criteria.

Level and Components of Total Tax Payments

The amount of tax revenue collected by government is the complement of the after-tax investment incentive. For example, the before-tax net present value for a project minus the after-tax net present value equals the present value of total tax payments. Thus, it will not be surprising to find that the greatest amount of tax is collected from the mining projects in British Columbia.

This section examines the variation in total tax payments and the differences in the components of those revenues among the eight provinces.

The total level of taxation borne by the tungsten and gold mines is presented in tables 30 and 31, respectively, expressed as undiscounted

Table 30

TOTAL TAX PAYMENTS FROM TUNGSTEN PROJECT: NOVA SCOTIA BASE CASE CONDITIONS

Taxation Regime	Taxation Payments ($ million)		
	Undiscounted	Present Value at 3%	Present Value at 10%
Nova Scotia	165.0	111.9	50.9
New Brunswick	200.3	134.2	58.6
Newfoundland	202.4	137.7	62.8
Quebec	190.1	126.6	54.4
Ontario:			
More-accessible site	200.2	134.2	58.9
Less-accessible site	187.1	124.1	52.8
Manitoba	193.9	129.6	56.4
Saskatchewan	179.8	120.1	52.2
British Columbia	240.6	164.3	75.9

Table 31

TOTAL TAX PAYMENTS FROM GOLD PROJECT: NOVA SCOTIA BASE CASE CONDITIONS

Taxation Regime	Taxation Payments ($ million)		
	Undiscounted	Present Value at 3%	Present Value at 10%
Nova Scotia	12.3	9.5	5.5
New Brunswick	13.1	10.1	5.7
Newfoundland	14.7	11.5	6.9
Quebec	11.5	8.9	5.2
Ontario:			
More-accessible site	13.4	10.4	6.1
Less-accessible site	13.2	10.2	6.0
Manitoba	12.9	9.9	5.7
Saskatchewan	12.1	9.4	5.5
British Columbia	15.9	12.4	7.4

taxation payments, tax payments discounted to the start of development at a riskless rate of 3 percent, and tax payments discounted back at the 10 percent cost of capital rate.

In the case of the tungsten project, the taxation system in British Columbia yields the most tax, followed somewhat distantly by Ontario (more-accessible site), New Brunswick, and Newfoundland. The Nova Scotia, Saskatchewan, and Ontario (less-accessible site) tax regimes collect the lowest level of taxation payments.

For the gold project, British Columbia once again collects the greatest amount of tax revenue, followed by Newfoundland. The tax systems in Quebec, Saskatchewan, and Nova Scotia are characterized by the lowest level of taxation payments.

The components of the present value of tax payments at 3 percent are shown in table 32 for the tungsten project and in table 33 for the gold mine development opportunity. Striking differences exist in the make-up of tax revenues among the provinces.

In the case of the tungsten project: the federal corporate income tax component is shown to vary from 50 percent of total payments in Nova Scotia to 34 percent in British Columbia, provincial corporate income tax

Table 32

TAX PAYMENT COMPONENTS FOR TUNGSTEN PROJECT: NOVA SCOTIA BASE CASE CONDITIONS
(percent of present value of tax payments at 3%)

Taxation Regime	Tax Components				
	Federal Corporate Income Tax	Corporate Income Tax	Provincial Mining Tax	Provincial Royalty	Provincial Non-Profit Taxes
Nova Scotia	50.4	24.4	1.5	11.9	11.8
New Brunswick	42.0	20.3	21.7	5.7	10.3
Newfoundland	41.0	21.1	26.7	-	11.2
Quebec	44.6	7.9	42.9	-	4.6
Ontario:					
More-accessible site	42.0	18.4	28.6	-	11.0
Less-accessible site	45.4	19.9	30.9	-	3.8
Manitoba	43.6	22.4	26.4	-	7.6
Saskatchewan	47.1	24.2	21.8	-	6.9
British Columbia	34.4	24.9	24.9	-	15.8

from 25 percent in British Columbia to 8 percent in Quebec, the combined provincial mining tax and royalty from 43 percent in Quebec to 13 percent in Nova Scotia, and non-profit taxes from 16 percent in British Columbia to 4 percent in Ontario.

Somewhat less pronounced differences in tax revenue components among provinces may be noted in table 33 for the gold project. The federal corporate income tax share changes from 45 percent in Quebec to 33 percent in British Columbia, provincial corporate income tax from 25 percent in British Columbia to 8 percent in Quebec, combined provincial mining tax and royalty from 32 percent in New Brunswick, Quebec and Manitoba to 25 percent in Saskatchewan, and non-profit taxes from 17 percent in Newfoundland to 7 percent in Manitoba.

Table 33

TAX PAYMENT COMPONENTS FOR GOLD PROJECT: NOVA SCOTIA BASE CASE CONDITIONS (percent of present value of tax payments at 3%)

Taxation Regime	Tax Components				
	Federal Corporate Income Tax	Corporate Income Tax	Provincial Mining Tax	Provincial Royalty	Provincial Non-Profit Taxes
Nova Scotia	42.6	20.7	25.0	3.0	8.7
New Brunswick	40.1	19.6	24.0	8.2	8.1
Newfoundland	35.1	18.3	29.2	-	17.4
Quebec	45.3	8.0	31.6	-	15.1
Ontario:					
More-accessible site	38.7	18.1	29.2	-	14.0
Less-accessible site	39.5	18.4	29.8	-	12.3
Manitoba	40.7	21.1	31.6	-	6.6
Saskatchewan	43.0	22.3	25.3	-	9.4
British Columbia	32.6	24.6	26.7	-	16.1

Graphical summaries of the results presented in tables 30-33 are presented in figures 10-11, showing variations in the level and components of total tax payments together.

Tax Payments as a Proportion of Before-Tax Project Value

The incidence of taxation from the mining company's viewpoint may be further illustrated by comparing the company's after-tax profit share and the governments' taxation share of before-tax net present values for the tungsten and gold projects.

This income-based comparison of profit and taxation shares is presented in table 34 and figures 12-13. The governments' taxation share may be viewed as an 'effective tax rate'. These results, as those previously presented, assume an individual project basis of taxation.

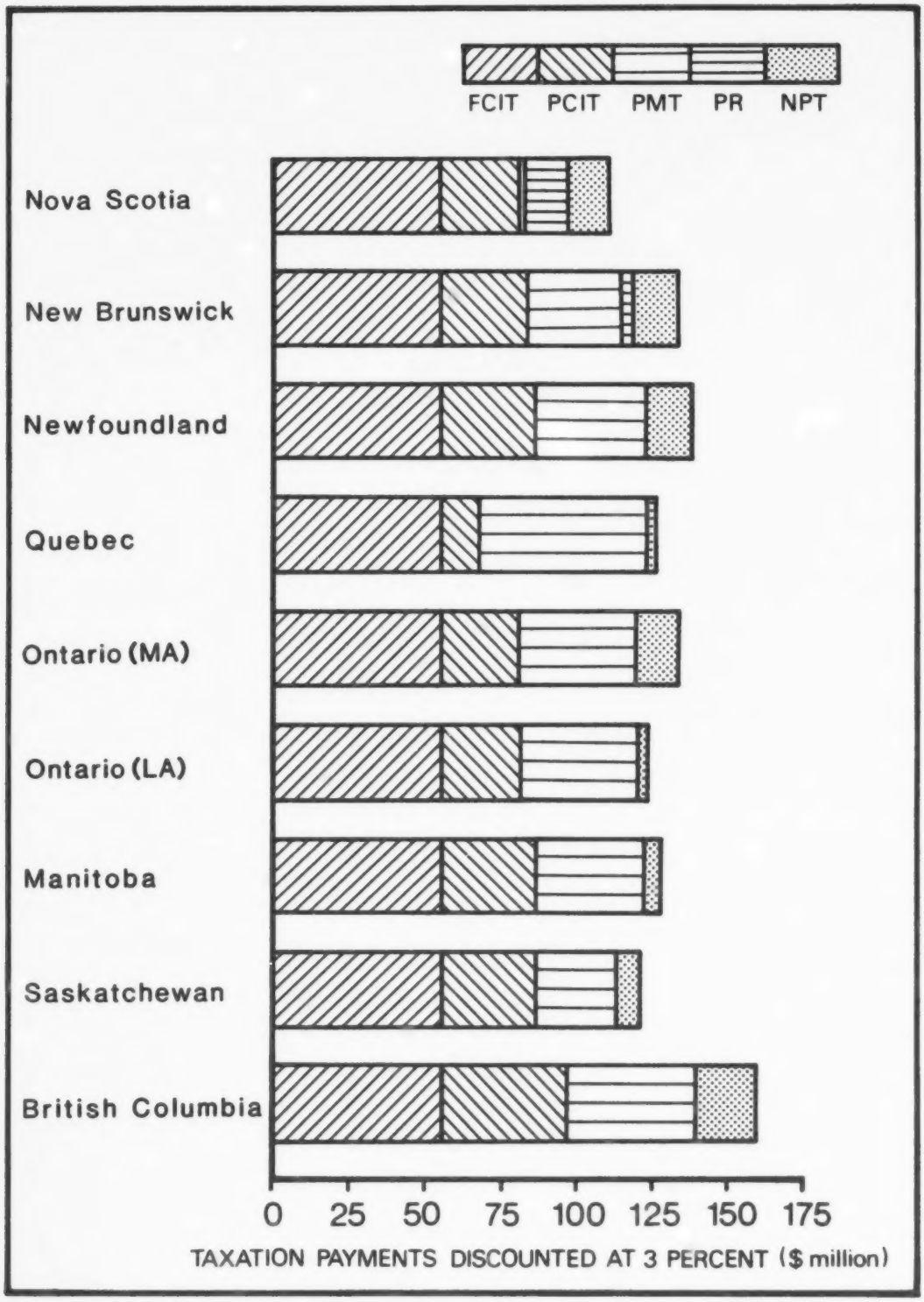

Figure 10. Total Tax Payments and Components: Tungsten Project, Nova Scotia Base Case Conditions

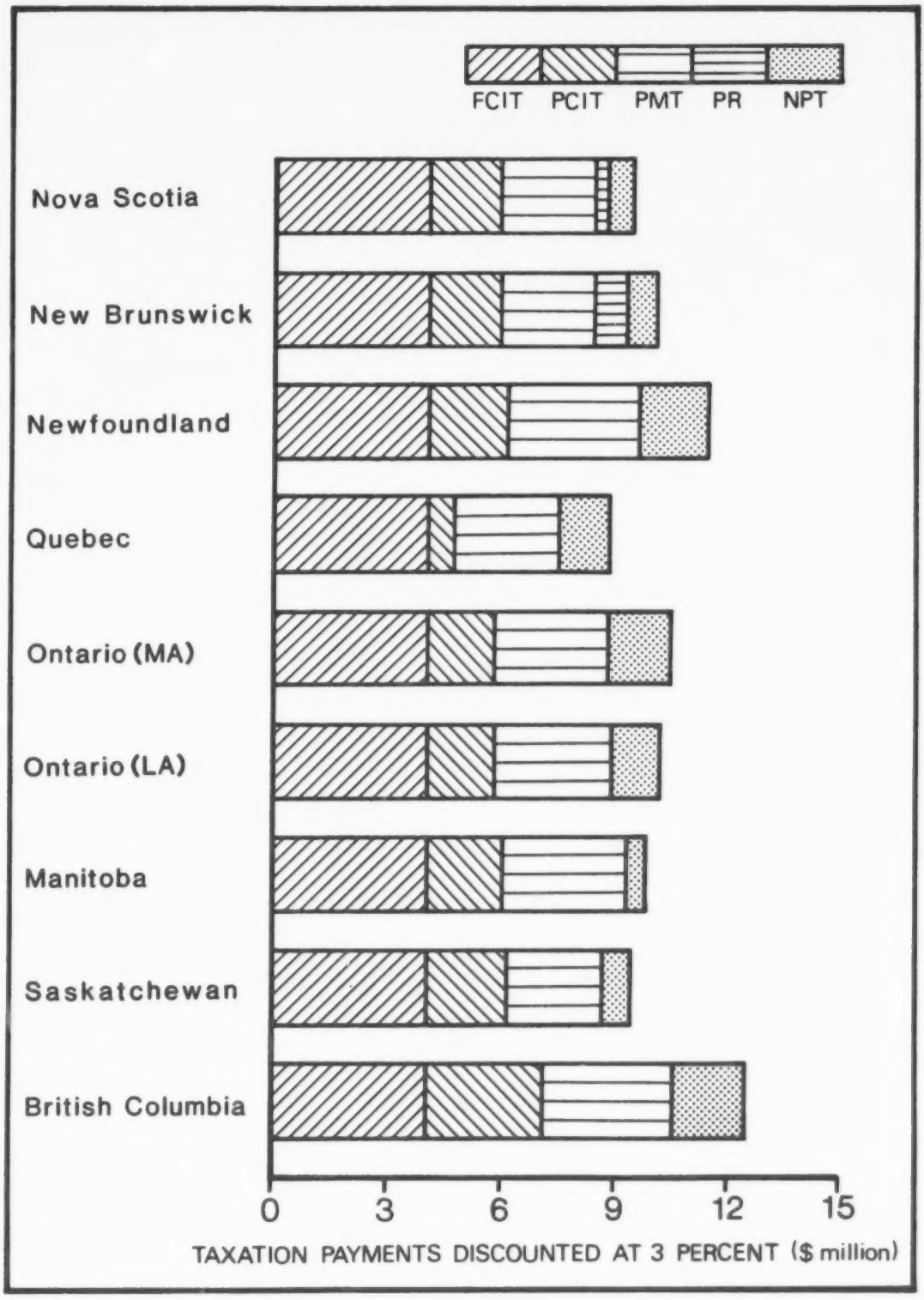

Figure 11. Total Tax Payments and Components: Gold Project, Nova Scotia Base Case Conditions

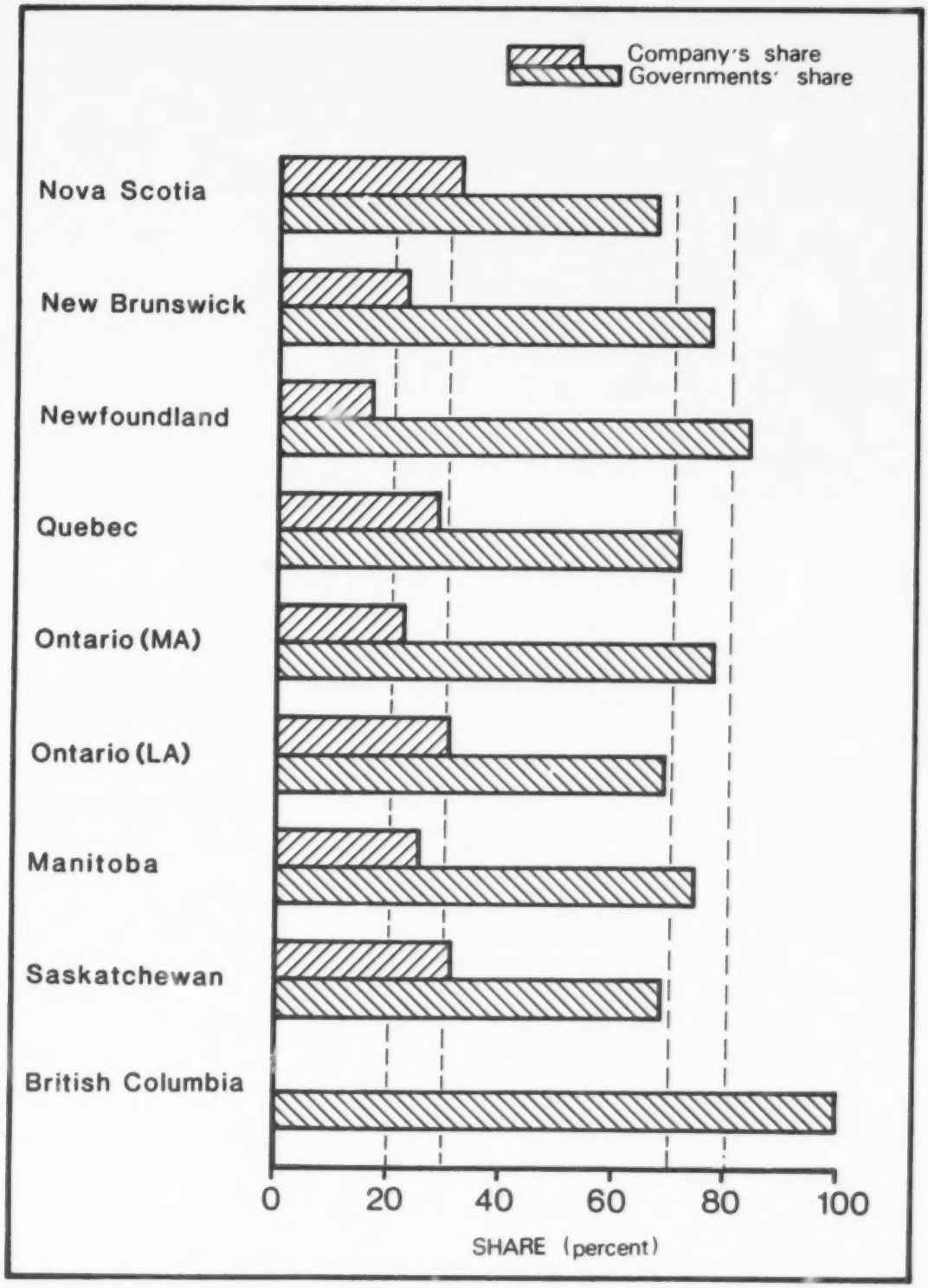

Figure 12. Company and Government Shares of Before-Tax Net Present Value: Tungsten Project, Nova Scotia Base Case Conditions

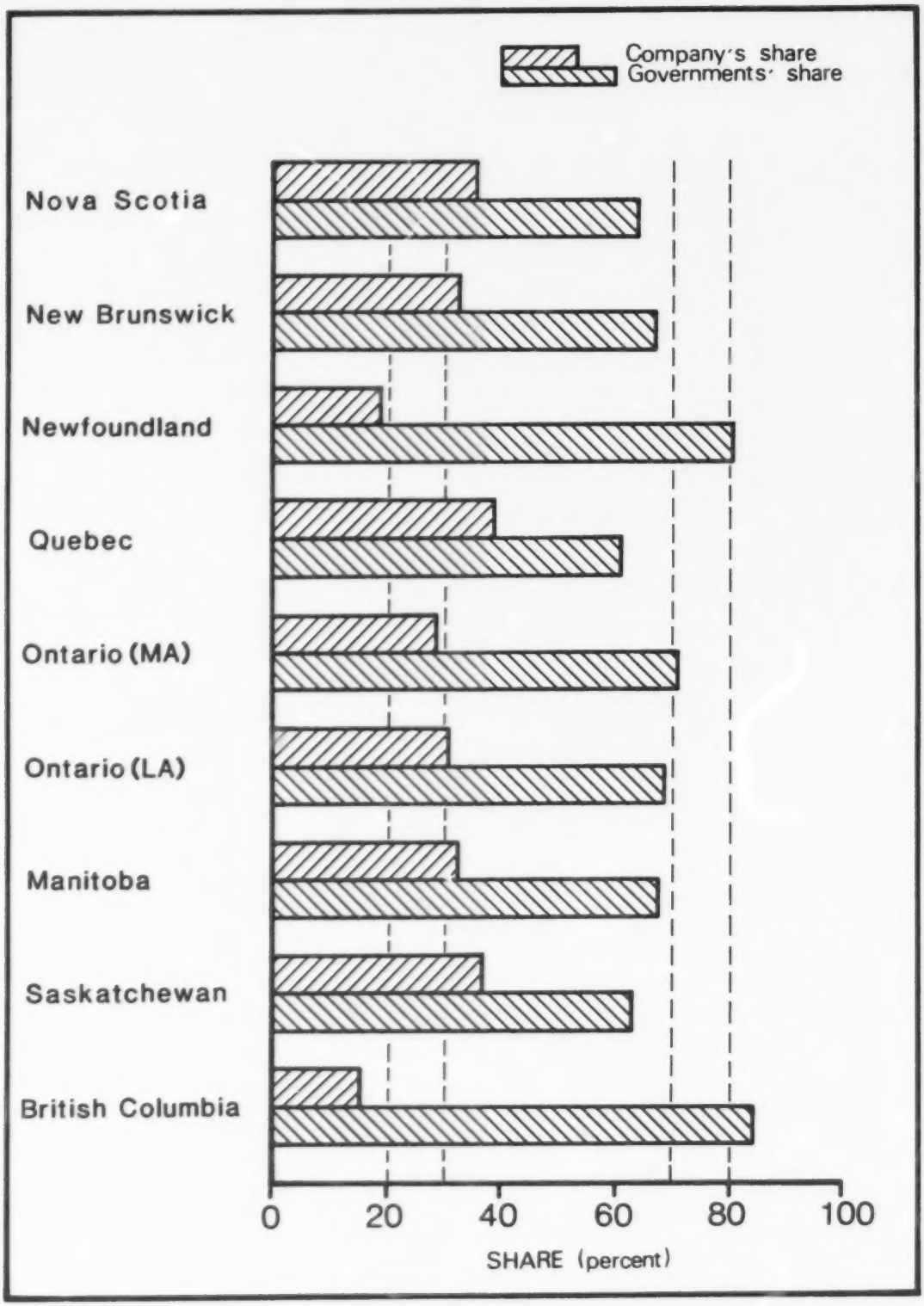

Figure 13. Company and Government Shares of Before-Tax Net Present Value: Gold Project, Nova Scotia Base Case Conditions

Table 34

TOTAL TAX PAYMENTS EXPRESSED AS A PROPORTION OF BEFORE-TAX NET PRESENT VALUE at 10%: NOVA SCOTIA BASE CASE CONDITIONS
(percent)

Taxation Regime	Tungsten Project		Gold Project	
	Company's Profit Share	Governments' Taxation Share	Company's Profit Share	Governments' Taxation Share
Nova Scotia	32.9	67.1	35.3	64.7
New Brunswick	22.8	77.2	32.9	67.1
Newfoundland	17.2	82.8	18.8	81.2
Quebec	28.3	71.7	38.8	61.2
Ontario:				
More-accessible site	22.4	77.6	28.2	71.8
Less-accessible site	30.4	69.6	30.6	69.4
Manitoba	25.7	74.3	32.9	67.1
Saskatchewan	31.1	68.9	36.5	63.5
British Columbia	0.0	100.0	14.1	85.9

On average, the company's profit share represents only 24 percent of the before-tax value of the medium-size open pit tungsten mine, and 30 percent of the value of the small underground gold mine. The complementary average government tax shares are 76 percent and 70 percent respectively.

For the tungsten project, the profit-taxation shares vary from 33-67 percent in Nova Scotia to 0-100 percent in British Columbia. Similarly, in the case of the gold project, the company-government shares vary from 39-61 percent in Quebec to 14-86 percent in British Columbia.

Tax Payments as a Proportion of Total Project Costs

In order to provide a perspective on the role of taxation in a mine's overall cost structure, table 35 provides an expense-based comparison of

Table 35

TOTAL TAX PAYMENTS EXPRESSED AS A PROPORTION OF THE PRESENT VALUE OF TOTAL COSTS AND TAXES at 10%: NOVA SCOTIA BASE CASE CONDITIONS
(percent)

Taxation Regime	Tungsten Project	Gold Project
Nova Scotia	14.7	14.9
New Brunswick	16.6	15.2
Newfoundland	17.6	17.9
Quebec	15.8	14.1
Ontario:		
More-accessible site	16.9	16.1
Less-accessible site	15.4	15.8
Manitoba	16.3	15.3
Saskatchewan	15.3	14.7
British Columbia	20.6	18.8

taxes. Total taxes incurred by the representative tungsten and gold projects are expressed, in present value terms, as a proportion of total project costs including tax payments.

For the tungsten project, total tax payments account for between 15 percent of total costs in Nova Scotia, Saskatchewan and Ontario (less-accessible site) to 21 percent in British Columbia. In the case of the gold mine, tax payments represent from 14 percent of total costs in Quebec, to 19 percent in British Columbia.

Integrated Company Tax Base

An integrated company has the ability to claim tax allowances as soon as they become available, rather than having to await project income as is assumed using individual project taxation. Tables 36 and 37 show the effects of taxation on the tungsten and gold projects for integrated companies having existing sources of income.

Table 36

EFFECT OF TAXATION ON ECONOMIC INDICATORS: INTEGRATED COMPANY TAXATION, NOVA SCOTIA BASE CASE CONDITIONS

	Tungsten Project		Gold Project	
	Net Present Value at 10% ($ million)	Rate of Return (percent)	Net Present Value at 10% ($ million)	Rate of Return (percent)
Before-tax results	75.9	18.5	8.5	25.5
After-tax results				
Taxation regime:				
Nova Scotia	38.7	16.2	4.1	21.5
New Brunswick	30.9	15.5	3.9	21.7
Newfoundland	26.8	14.6	2.8	18.4
Quebec	33.6	15.8	4.3	21.5
Ontario:				
More-accessible site	31.3	15.6	3.6	20.5
Less-accessible site	36.9	16.6	3.8	20.9
Manitoba	33.3	15.9	3.9	21.4
Saskatchewan	37.2	16.4	4.2	21.7
British Columbia	18.6	13.4	2.7	17.9

These results illustrate the important tax advantage realized by integrated companies. The after-tax measures of investment incentive are significantly higher than for the individual project basis of taxation (table 27). Consequently, the average company profit share increases to about 43 percent as compared to only 27 percent for the individual project basis of taxation. The government taxation share is correspondingly reduced from 73 percent to 57 percent.

A comparison of results for integrated company and individual project tax bases shows that competitive rankings among the provinces remain essentially unchanged.

Table 37

TOTAL TAX PAYMENTS EXPRESSED AS A PROPORTION OF BEFORE-TAX NET PRESENT VALUE at 10%: INTEGRATED COMPANY TAXATION, NOVA SCOTIA BASE CASE CONDITIONS
(percent)

Taxation Regime	Tungsten Project		Gold Project	
	Company's Profit Share	Governments' Taxation Share	Company's Profit Share	Governments' Profit Share
Nova Scotia	51.0	49.0	48.2	51.8
New Brunswick	40.7	59.3	45.9	54.1
Newfoundland	35.3	64.7	32.9	67.1
Quebec	44.3	55.7	50.6	49.4
Ontario:				
More-accessible site	41.2	58.8	42.4	57.6
Less-accessible site	48.6	51.4	44.7	55.3
Manitoba	43.9	56.1	45.9	54.1
Saskatchewan	49.0	51.0	49.4	50.6
British Columbia	24.5	75.5	31.8	68.2

After-Tax Breakeven Ore Grades

The effects of taxation may also be viewed in terms of breakeven ore grades. Table 38 shows the variation among provinces in the breakeven tungsten and gold grades required to yield a minimum acceptable 10-percent rate of return on investment. These differences arise because of the differences in tax burden which currently exist among the eight provinces.

Table 38

AFTER-TAX BREAKEVEN ORE GRADES: NOVA SCOTIA BASE CASE CONDITIONS

	Tungsten Deposit ($\% WO_3$)	Gold Deposit (grams Au per tonne)
Before-Tax Results	.135	7.41
After-Tax Results		
Taxation Regime:		
Nova Scotia	.153	8.13
New Brunswick	.156	8.13
Newfoundland	.160	8.68
Quebec	.152	8.14
Ontario:		
More-accessible site	.156	8.37
Less-accessible site	.153	8.31
Manitoba	.155	8.17
Saskatchewan	.153	8.16
British Columbia	.170	8.88

The after-tax breakeven recoverable tungsten grades vary from .152 percent tungsten trioxide in Quebec to .170 percent tungsten trioxide in British Columbia, relative to a before-tax grade requirement of .135 percent tungsten trioxide. Similarly, the after-tax breakeven gold grades vary from 8.13 grams per tonne in Nova Scotia and New Brunswick to 8.88 grams per tonne in British Columbia, relative to a minimum acceptable before-tax grade requirement of 7.41 grams per tonne.

6. COMBINED IMPACT OF BEFORE-TAX AND TAXATION CONDITIONS

Having separately evaluated and compared the effects of before-tax conditions and taxation policies in chapters 4 and 5 respectively, the combined impact of these locational factors on mine development and exploration potential is examined in this final chapter. To do this, the before-tax region and site variants are combined with appropriate provincial tax regimes for the evaluation of after-tax economic indicators.

After-Tax Investment Incentive

After-tax measures of investment incentive are presented in table 39 for the tungsten project and in table 40 for the gold mine.

Table 39

COMBINED IMPACT OF BEFORE-TAX AND TAXATION LOCATIONAL CONDITIONS ON ECONOMIC INDICATORS FOR TUNGSTEN PROJECT

Location	After-Tax Net Present Value at 10% ($ million)	After-Tax Rate of Return (percent)
Nova Scotia	25.0	13.3
New Brunswick	17.3	12.5
Newfoundland	13.0	11.8
Quebec:		
More-accessible site	20.1	12.9
Less-accessible site	9.0	11.2
Ontario:		
More-accessible site	15.5	12.2
Less-accessible site	10.6	11.4
Manitoba:		
More-accessible site	18.1	12.6
Less-accessible site	6.8	10.9
Saskatchewan:		
More-accessible site	22.2	13.1
Less-accessible site	10.4	11.4
British Columbia:		
More-accessible site	-10.9	8.5
Less-accessible site	-27.1	6.5

Table 40

COMBINED IMPACT OF BEFORE-TAX AND TAXATION LOCATIONAL CONDITIONS ON ECONOMIC INDICATORS FOR GOLD PROJECT

Location	After-Tax Net Present Value at 10% ($ million)	After-Tax Rate of Return (percent)
Nova Scotia	3.0	16.7
New Brunswick	2.8	16.6
Newfoundland	1.6	13.7
Quebec:		
More-accessible site	2.3	14.8
Less-accessible site	-1.9	6.9
Ontario:		
More-accessible site	1.5	13.2
Less-accessible site	-2.3	6.3
Manitoba:		
More-accessible site	1.9	14.2
Less-accessible site	-1.8	7.0
Saskatchewan:		
More-accessible site	2.1	14.4
Less-accessible site	-1.7	7.2
British Columbia:		
More-accessible site	-2.5	5.4
Less-accessible site	-9.5	-3.1

In the case of the tungsten project, the Nova Scotia, Saskatchewan (more-accessible), and Quebec (more-accessible) locations provide the most investment incentive while British Columbia (less- and more-accessible sites), Manitoba (less-accessible site), and Quebec (less-accessible site) represent the least favourable locations. For the gold project, the Nova Scotia, New Brunswick, and Quebec (more-accessible) locations provide the strongest incentive for investment, while the British Columbia (less- and more-accessible), Ontario (less-accessible), and Quebec (less-accessible) locations offer the least favourable results.

In all cases, Nova Scotia represents the most competitive location and British Columbia the least competitive location for investment. For the assumed conditions, the tungsten and gold projects located in British Columbia are both uneconomic at both the less-accessible and more-accessible minesites.

Generally speaking, the before-tax and taxation rankings appear to be positively correlated. Thus, the combined impact of these locational com-

ponents tends to widen the differences in competitive position among provinces.[14]

Metal Price Variants

Expected metal prices are used in tables 39 and 40 to rank provinces in terms of the relative favourability of their location. In this section, the more general validity of these rankings is considered by evaluating the sensitivity of the after-tax measures of investment incentive to the lower-limit and upper-limit metal price projections specified in table 1.

Table 41 shows the sensitivity analysis results for the tungsten project, while after-tax economic indicators for the gold project are pre-

Table 41

COMBINED IMPACT OF BEFORE-TAX AND TAXATION LOCATIONAL CONDITIONS ON ECONOMIC INDICATORS FOR TUNGSTEN PROJECT: METAL PRICE VARIANTS

Location	After-Tax Net Present Value at 10% ($ million)		After-Tax Rate of Return (percent)	
	Lower-Limit Prices	Upper-Limit Prices	Lower-Limit Prices	Upper-Limit Prices
Nova Scotia	-90.4	115.3	-4.6	24.9
New Brunswick	-90.4	107.6	-4.9	24.8
Newfoundland	-90.8	101.2	-5.1	23.3
Quebec:				
More-accessible site	-82.1	105.8	-2.5	24.4
Less-accessible site	-99.8	96.1	-5.6	22.5
Ontario:				
More-accessible site	-91.9	96.8	-4.9	23.4
Less-accessible site	-98.2	93.2	-5.2	22.3
Manitoba:				
More-accessible site	-86.8	106.1	-3.4	24.1
Less-accessible site	-104.6	96.8	-6.5	22.3
Saskatchewan:				
More-accessible site	-84.3	117.5	-2.9	24.9
Less-accessible site	-101.8	107.6	-5.9	23.1
British Columbia:				
More-accessible site	-123.0	74.9	-13.1	20.0
Less-accessible site	-132.7	61.9	..	17.7

.. less than -20 percent rate of return.

14. However, in some cases, Newfoundland for example, the relative before-tax and taxation differences tend to cancel.

sented in table 42. The after-tax results at lower-limit prices are not particularly meaningful other than to indicate that, if these market conditions were to prevail, the tungsten and gold projects would be quite uneconomic at all locations. Also, it may be noted that the greater discrepancies between the cost of capital discount rate and the project rates of return provide more scope for the appearance of contradictory results between the net present value and rate of return indicators than at expected prices.

Table 42

COMBINED IMPACT OF BEFORE-TAX AND TAXATION LOCATIONAL CONDITIONS ON ECONOMIC INDICATORS FOR GOLD PROJECT: METAL PRICE VARIANTS

Location	After-Tax Net Present Value at 10% ($ million)		After-Tax Rate of Return (percent)	
	Lower-Limit Prices	Upper-Limit Prices	Lower-Limit Prices	Upper-Limit Prices
Nova Scotia	-8.0	14.4	-12.2	38.7
New Brunswick	-7.8	13.6	-12.0	38.6
Newfoundland	-9.2	12.1	-17.9	34.4
Quebec:				
More-accessible site	-9.6	14.5	-16.5	36.6
Less-accessible site	-13.1	11.0	..	26.3
Ontario:				
More-accessible site	-10.1	12.3	-18.5	33.2
Less-accessible site	-13.1	9.3	..	24.2
Manitoba:				
More-accessible site	-8.9	12.6	-13.4	34.3
Less-accessible site	-13.1	9.6	..	24.8
Saskatchewan:				
More-accessible site	-9.1	13.8	-14.3	35.5
Less-accessible site	-13.1	10.6	..	25.7
British Columbia:				
More-accessible site	-11.7	8.3	..	24.8
Less-accessible site	-17.0	3.6	..	14.7

.. less than -20 percent rate of return

Nevertheless, the provincial rankings are generally consistent with those shown in tables 39-40 for expected prices. Nova Scotia is in all cases among the two or three most competitive provinces in terms of after-tax investment incentive, while British Columbia provides the least attractive after-tax results throughout.

After-Tax Breakeven Ore Grades

Finally, the after-tax breakeven tungsten and gold grades required for a 10-percent minimum acceptable return on investment are determined. In terms of locational conditions, the chances of exploration success are inversely related to these breakeven grades. Results are presented in table 43 and figures 14-15.

Table 43

COMBINED IMPACT OF BEFORE-TAX AND TAXATION LOCATIONAL CONDITIONS ON BREAK-EVEN ORE GRADES

Location	Tungsten Deposit (% WO_3)	Gold Deposit (grams per tonne Au)
Nova Scotia	.153	8.13
New Brunswick	.156	8.13
Newfoundland	.160	8.68
Quebec:		
More-accessible site	.153	8.53
Less-accessible site	.162	10.08
Ontario:		
More-accessible site	.157	8.77
Less-accessible site	.161	10.27
Manitoba:		
More-accessible site	.155	8.56
Less-accessible site	.165	10.13
Saskatchewan:		
More-accessible site	.153	8.54
Less-accessible site	.161	10.07
British Columbia:		
More-accessible site	.179	10.45
Less-accessible site	.193	12.83

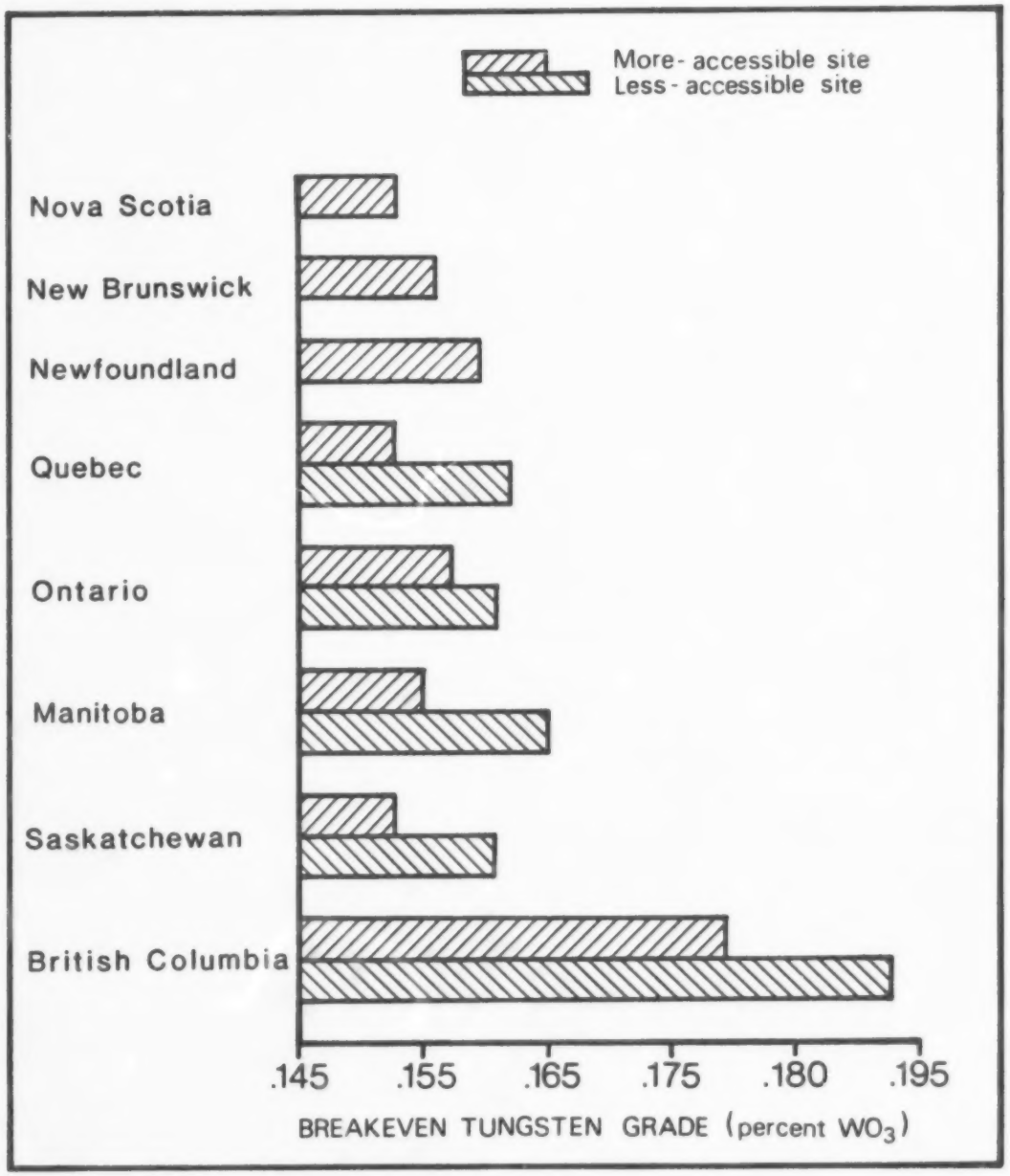

Figure 14. Combined Impact of Before-Tax and Taxation Locational Conditions on Breakeven Tungsten Grades

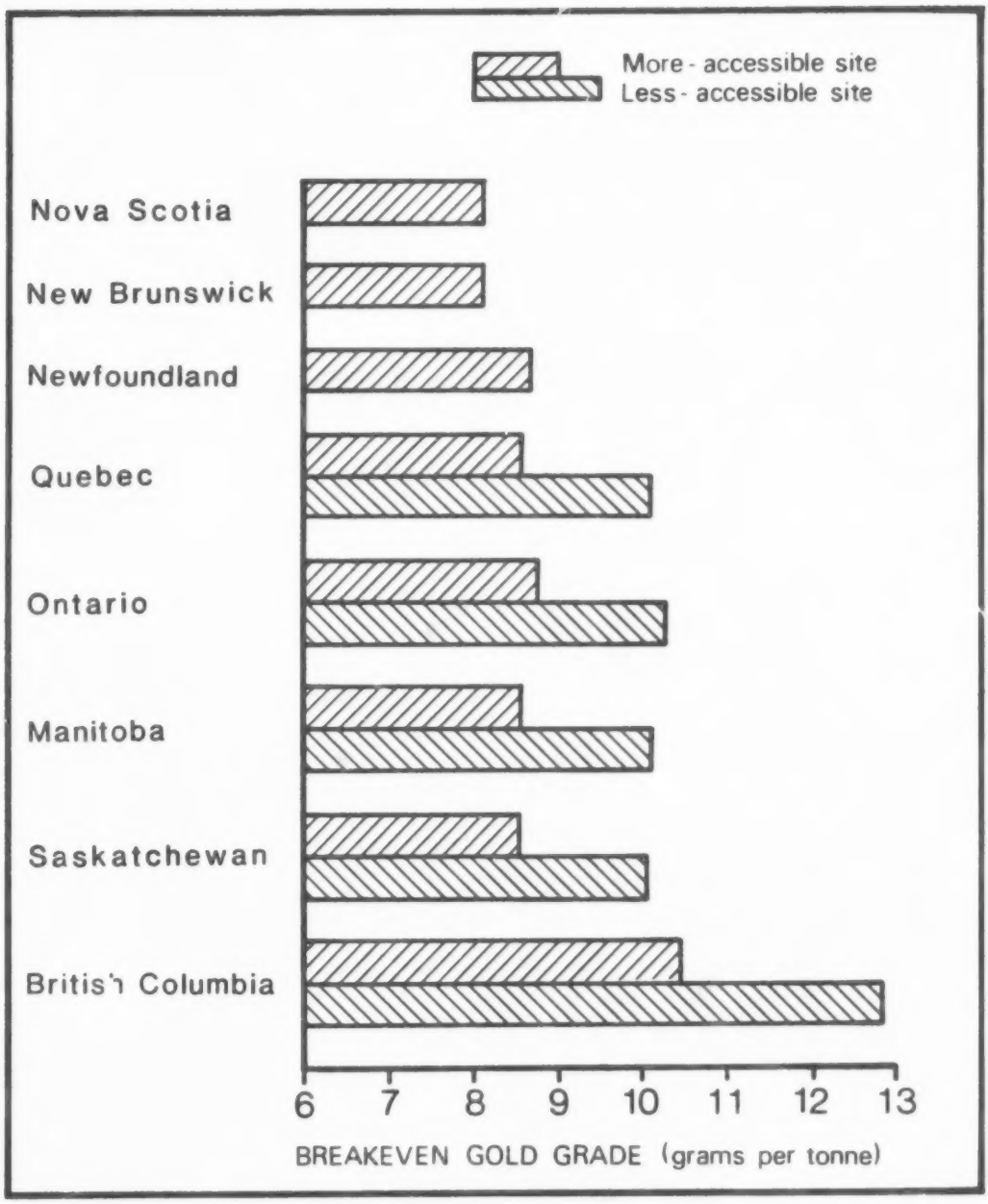

Figure 15. Combined Impact of Before-Tax and Taxation Locational Conditions on Breakeven Gold Grades

The tungsten grade requirement is shown to vary from .153 percent tungsten trioxide at the Nova Scotia, Quebec (more-accessible), and Saskatchewan (more-accessible) locations to .193 percent tungsten trioxide at the less-accessible minesite in British Columbia. In the case of the gold deposit, the minimum acceptable grade varies from 8.13 grams per tonne in the Nova Scotia and New Brunswick locations, to 12.83 grams per tonne at the less-accessible site in British Columbia. Thus, undiscovered gold deposits with grades between 8.13 and 12.83 grams per tonne represent economic exploration targets in the former cases but would be uneconomic in the latter situation.

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APPENDIX A

DETERMINATION OF WAGE AND SALARY RATE DIFFERENTIALS

Rate Differentials for Hourly and Salaried Employees

Source

Statistics Canada, catalogue 72-002, monthly.

Statistics

Average hourly earnings (including overtime) by province. Hourly and salaried employees.

Industry Classification

Mine production: use 'Mine, Quarries and Oil Wells' series.
Mine development: use 'Construction' series.

Time Series

July - August, 1984.
March - April, 1984.
July - August, 1983.
March - April, 1983.

Regional Averages

For Nova Scotia: use average of Nova Scotia and New Brunswick.
For Central Canada: use average of Quebec, Ontario, and Manitoba.
For Western Canada: use British Columbia.

Table 44

REGIONAL RATES AND DIFFERENTIALS FOR HOURLY WORKERS EMPLOYED IN MINE DEVELOPMENT
($ per hour)

Month	Nova Scotia (1)	Central Canada (2)	Differential (2/1)	Western Canada (3)	Differential (3/1)
1984 - August	10.225	12.850	1.26	17.69	1.73
July	10.085	12.800	1.27	17.48	1.73
April	11.540	13.433	1.16	17.80	1.54
March	11.455	13.713	1.20	17.99	1.57
1983 - August	9.445	13.023	1.38	18.43	1.95
July	9.370	12.930	1.38	18.16	1.94
April	11.005	13.097	1.19	17.65	1.60
March	10.985	13.067	1.19	17.60	1.60
Average	10.514	13.114	1.247	17.85	1.698

Table 45

REGIONAL RATES AND DIFFERENTIALS FOR SALARIED WORKERS EMPLOYED IN MINE DEVELOPMENT
($ per hour)

Month	Nova Scotia (1)	Central Canada (2)	Differential (2/1)	Western Canada (3)	Differential (3/1)
1984 - August	8.915	9.907	1.11	11.38	1.28
July	8.885	9.907	1.12	11.36	1.28
April	8.400	10.007	1.19	11.43	1.36
March	8.850	9.990	1.13	11.81	1.33
1983 - August	9.670	10.737	1.11	12.69	1.31
July	9.430	10.773	1.14	12.81	1.36
April	9.510	10.707	1.13	12.79	1.34
March	9.610	10.633	1.11	12.92	1.34
Average	9.159	10.333	1.128	12.149	1.326

Table 46

REGIONAL RATES AND DIFFERENTIALS FOR HOURLY WORKERS EMPLOYED IN MINE PRODUCTION
($ per hour)

Month	Nova Scotia (1)	Central Canada (2)	Differential (2/1)	Western Canada (3)	Differential (3/1)
1984 - August	12.825	14.340	1.12	17.39	1.36
July	12.565	14.557	1.16	17.07	1.36
April	13.600	14.330	1.05	17.25	1.27
March	12.770	14.353	1.12	16.62	1.30
1983 - August	11.385	13.423	1.18	15.57	1.37
July	11.110	13.390	1.21	15.40	1.39
April	12.045	13.873	1.15	15.95	1.32
March	13.910	14.003	1.01	15.75	1.13
Average	12.526	14.034	1.120	16.375	1.307

Table 47

REGIONAL RATES AND DIFFERENTIALS FOR SALARIED WORKERS EMPLOYED IN MINE PRODUCTION
($ per hour)

Month	Nova Scotia (1)	Central Canada (2)	Differential (2/1)	Western Canada (3)	Differential (3/1)
1984 - August	17.030	16.630	.98	18.94	1.11
July	16.285	16.347	1.00	18.87	1.16
April	16.440	16.957	1.03	19.04	1.16
March	16.465	16.877	1.03	19.10	1.16
1983 - August	15.275	15.400	1.01	17.70	1.16
July	15.340	15.120	.99	17.79	1.16
April	15.050	15.400	1.02	17.82	1.18
March	15.040	15.080	1.00	17.78	1.18
Average	15.866	15.976	1.007	18.38	1.158

Average Proportions of Hourly and Salaried Employees

Source

Statistics Canada, catalogue 72-002, monthly.

Statistic

Average weekly earnings (including overtime) for Canada.
Hourly employees, salaried employees, all employees.

Industry Classification

Mine production: use 'Metal Mines' series.
Mine development: use 'Construction' series.

Time Series

Monthly averages for period January-August, 1984.

Let: x = % salaried employes;
y = % hourly employees;
x+y = 100 = all employees.

Mine Development

$$x\,(415.21) + y\,(509.62) = 100(472.85)$$
$$415.21x + (100 - x)\,(509.62) = 47285$$
$$415.21x + 50962 - 509.62x = 47285$$
$$94.41x = 3677$$
$$x = 38.9 \;;\; y = 61.1$$

Salaried: 39% ; Hourly: 61%

Mine Production

$$x\,(701.48) + (100 - x)\,(589.47) = 100(622.60)$$
$$701.48x + 58947 - 589.47x = 62260$$
$$112.01x = 3313$$
$$x = 29.6 \;;\; y = 70.4$$

Salaried: 30% ; Hourly: 70%

Weighted Average Wage and Salary Rate Differentials
(relative to estimated rates for Nova Scotia)

Mine Development

Central Canada: .39(1.128) + .61(1.247) = 1.2006 or +20%

Western Canada: .39(1.326) + .61(1.698) = 1.5529 or +55%

Mine Production

Central Canada: .30(1.007) + .70(1.120) = 1.0861 or +9%

Western Canada: .30(1.158) + .70(1.307) = 1.2623 or +26%

APPENDIX B

CALCULATION OF FEDERAL AND PROVINCIAL INCOME AND MINING TAXES

Federal Corporate Income Tax

Cash Flow Format:

Revenue
- Operating Cost
- Capital Cost Allowance @ 30% db (optional)
- Interest Payments

If negative: Carried Loss (for year X+1 or X-1)

Revenue
- Operating Cost

Net Income before Allowances
- Inventory Allowance
- Capital Cost Allowance

Resource Profits
- Resource Allowance
- Interest Payments
- Exploration Expenditures
- Development Expenditures

Income for Earned Depletion
- Earned Depletion Allowance
- Carried Loss (from X-1 or X+1)

Income for Federal Corporate Income Tax

Federal Corporate Income Tax Otherwise Payable
- Investment Tax Credit

Net Federal Corporate Income Tax Payable

Inventory Allowance: 3% of the cost of 'inventory' is allowable each year. Inventory includes operating supplies and the cost of concentrate produced and not sold, but not spare parts. In accounting terms, if working capital (current assets) comprises receivables and inventory, the allowance is determined on the inventory portion.

ASSUME - 50% of working capital is applicable to the determination of inventory allowance.

Capital Cost Allowance: applied to mine plant and machinery, the mill facility, infrastructure capital, and mine development capital after the start of commercial production. The amount allowable must be reduced by the investment tax credit (see below).

For capital expended during the development stage and for expansions of at least 25% in capacity, the deduction permitted is the greater of 15% of the allowable capital cost in the year of expenditure and 30% per year thereafter on a declining balance basis, or an amount equal to (revenue - operating cost - interest payments) from the new mine, i.e. at 100% against new mine income.

ASSUME - taxation on an individual project basis will use the 100% rate. Taxation on an integrated company basis will use the 15% and 30% rates until new mine income begins and then the balance will be deducted at the 100% rate. Note that while capital cost allowance reduces the amount of resource profits and resource allowance, a carried loss does not. Therefore, using the 15% and 30% rates until new mine income begins may be advantageous even on the individual project basis.

For other capital costs (apart from major expansion) and sustaining capital costs, the capital cost allowance is 15% of the capital cost in the year of expenditure and 30% per year thereafter on a declining balance basis for all except mine development capital costs which are allowable at 100%.

Capital expenditures incurred to control air and water pollution can be deducted at 50% per year on a straight-line basis.

Resource Allowance: 25% of resource profits.

Development Expenditures: mine development capital costs incurred before the start of commercial production are allowed to be deducted at 100%.

Earned Depletion Allowance: $1 for every $3 of allowable capital costs and expenditures up to a maximum of 25% of income for earned depletion in any year.

Allowable capital costs and expenditures include exploration expenditures; mine development, mine plant and machinery, mill facility, and infrastructure capital in the development stage; mine plant and machinery, and mill facility capital associated with a major expansion; and the processing

machinery equipment component in other capital costs (other than major expansions) and sustaining capital costs. The amount allowable must be reduced by the investment tax credit (see below).

Carried Loss: losses may be carried back three years and ahead seven years.

Federal Corporate Income Tax: 36% of income for federal tax.

Investment Tax Credit: applies to mine plant and machinery, mill facility and infrastructure capital. The investment tax credit is deducted from the federal corporate income tax which would otherwise be payable to determine the net tax payable. The maximum deduction in any year is the federal corporate income tax otherwise payable.*

The basic rate of credit is 7%. This rate applies generally in southern Ontario, southwestern Quebec, and most of Alberta and British Columbia.

The rate of tax credit is 10% in areas designated under the Regional Development Incentives Act in Saskatchewan, Manitoba, northern Ontario, and Quebec other than the Gaspe region. Investments in the northern parts of Alberta and British Columbia, and the Yukon and Northwest Territories also qualify for the credit at this rate.

The rate of tax credit is 20% in the Atlantic Provinces and the Gaspe region of Quebec.

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* As a temporary measure for the period May, 1983 - April, 1986, 20% of any investment tax credits earned in excess of the federal tax otherwise payable is returnable as a cash refund.

Provincial and Territorial Corporate Income Tax

QUEBEC

Cash Flow Format:

Revenue
- Operating Cost
- Capital Cost Allowance @ 30% db (optional)
- Interest Payments

if negative: Carried Loss (for year X+1 or X-1)

Revenue
- Operating Cost

Net Income before Allowances
- Capital Cost Allowance
- Inventory Allowance

Resource Profits
- Resource Allowance
- Interest Payments
- Exploration Expenditures
- Development Expenditures

Income for Earned Depletion
- Earned Depletion Allowance
- Carried Loss (from X-1 or X+1)
- Income for Quebec Corporate Income Tax

Quebec Corporate Income Tax

} same format as for Federal Corporate Income Tax

Capital Cost Allowance
Inventory Allowance
Resource Allowance
Development Expenditures
Carried Loss

} Same rules as for Federal Corporate Income Tax

Earned Depletion Allowance: same rules as for federal corporate income tax except maximum annual deduction is 33 1/3% of income for earned depletion.

Quebec Corporate Income Tax: 5.5% of income for Quebec income tax.

ONTARIO

Cash Flow Format:

Revenue	same format
- Operating Cost	as for
- Capital Cost Allowance @ 30% db (optional)	Federal
- Interest Payments	Corporate
if negative: Carried Loss (for year X+1 or X-1)	Income Tax

Revenue
- Operating Cost
Net Income before Allowances
- Capital Cost Allowance
- Inventory Allowance
- Interest Payments
- Exploration Expenditures
- Development Expenditures
Income for Percentage Depletion
- Percentage Depletion Allowance
- Carried Loss (from year X-1 or X+1)
- Income for Ontario Corporate Income Tax
Ontario Corporate Income Tax

Capital Cost Allowance: same as for Federal Corporate Income Tax except that the deduction permitted is the greater of 30% per year of the allowable capital cost on a declining balance basis, or an amount equal to (revenue - operating cost - interest payments) from the new mine, i.e. at 100% against new mine income.

Inventory Allowance	Same rules as for
Development Expenditures	Federal Corporate
Carried Loss	Income Tax

Percentage Depletion Allowance: 33 1/3% of income for percentage depletion.

Ontario Corporate Income Tax: 14% of income for Ontario income tax.

OTHER PROVINCES AND TERRITORIES

In British Columbia, resource allowance is not an allowable deduction in calculating income for B.C. corporate income tax. Otherwise, income for provincial and territorial corporate income tax is derived in exactly the same way as income for federal corporate income tax.

The applicable tax rates are as follows:

Manitoba	16%
British Columbia	16%
Newfoundland	16%
Nova Scotia	15%
New Brunswick	15%
Saskatchewan	16%
Northwest Territories	10%
Yukon Territory	10%

Provincial and Territorial Mining Tax

NEWFOUNDLAND*

Cash Flow Format:

Revenue
- Operating Cost
Net Income before Allowances
- Depreciation Allowance
- Exploration Expenditures
Income for Processing Allowance
- Processing Allowance
Income for Newfoundland Mining Tax
Newfoundland Mining Tax

Depreciation Allowance: all pre-production capital costs allowable on a straight line basis over estimated mine life. Capital expended during the productive life of a mine is allowable at 10 percent on a straight-line basis.

Processing Allowance: 8% per year of the original cost of processing assets but not to be more than 65% of the income for processing allowance.

Newfoundland Mining Tax: 20% on first 20% of income for Newfoundland mining tax; 15% on remaining income for Newfoundland mining tax.

* The Iron Ore Company of Canada has a special tax agreement with the Newfoundland government. Their iron ore mining and processing operation in Labrador are taxed at a flat rate of 5% of taxable income. Depreciation allowance is 10% per year of all capital costs on a straight-line basis. There is no processing allowance. Interest and royalty payments are not deductible.

NOVA SCOTIA

Cash Flow Format:

Gross Metal Revenue
- Smelting, Refining, and Transportation Charges
Revenue = Net Smelter Return

Revenue
- Operating Cost
Net Income before Allowance
- Depreciation Allowance
- Exploration Expenditures
Income for Processing Allowance
- Processing Allowanc
Income for Nova Scotia Mining Tax
Nova Scotia Mining Tax

Depreciation Allowance: all capital costs except post-production mine access capital costs allowable at 100% against new mine income during the first three years of operation and at 30% per year on a straight-line basis thereafter. Post-production mine development capital costs allowable at 100%.

Processing Allowance: 8% per year of the original cost of processing assets but not to be less than 15% nor more than 65% of the income for processing allowance.

Nova Scotia Mining Tax: the greater of 2% of net smelter return or 15% of income for Nova Scotia mining tax (but subject to change by order-in-council).

NEW BRUNSWICK

Cash Flow Format:

Revenue
- Operating Cost
- Exploration Allowance
- Royalty
- Depreciation Allowance
- Interest Allowance
Income for Processing Allowance
- Processing Allowance
Income for New Brunswick Mining Tax
New Brunswick Mining Tax
- Research Credit
New Brunswick Mining Tax After Credit

Exploration Allowance: $1.50 for every $1 of exploration expenditures.

Royalty: 2% of 'net mill return' starting in the third year of mine operation.

Gross Metal Revenue
- Smelting, Refining, and Transportation Charges
Revenue
- Mill Operating Costs
Return for Processing Allowance
- Processing Allowance
Net Mill Return (i.e., value of the mill feed)

The processing allowance is determined as specified below but the amount deductible in any year cannot exceed 25% of the 'return for processing allowance'.

Depreciation Allowance: includes all capital expenditures except for exploration, research and working capital.

For capital expended during the preproduction development stage and for expansions of at least 25% in capacity, the deduction permitted is up to 100% of the allowable capital cost but not to be less than 5% per year.

Sustaining and other capital costs during the productive life of a mine are allowable at up to 33 1/3% per year on a straight-line basis with no minimum deduction.

New Brunswick (continued)

Assume maximum possible allowance is taken in each case.

Interest Allowance: 8% per year of the undepreciated cost of all assets qualifying for depreciation allowance. Note that it may in some cases be advantageous to depreciate more slowly than possible to take fuller advantage of this allowance.

Processing Allowance: annual rate applied to the original cost of processing assets but not to be less than 15 percent nor more than 65 percent of income for processing allowance.
8% of concentrator assets.
15% of smelting and refining assets.

New Brunswick Mining Tax:

income for mining tax	marginal rate
up to 100,000	exempt
100,000 and over	16%

Research Credit: 25% of research expenditures.

QUEBEC

Cash Flow Format:

Revenue
- Operating Cost
- Depreciation Allowance
- Exploration Expenditures } optional

Carried Loss

Revenue
- Operating Cost
- Depreciation Allowance
- Exploration Expenditures

Income for Exploration and Investment Allowance
- Exploration and Investment Allowance

Income for Processing Allowance
- Processing Allowance

Income for Quebec Mining Tax

Quebec Mining Tax Otherwise Payable
- Deduction for Carried Loss

Net Quebec Mining Tax Payable

Quebec (continued)

Depreciation Allowance: mine development capital costs at 100% per year; all other capital costs at 30% per year on a straight-line basis.

Exploration and Investment Allowance: $1 for every $3 of pre-production exploration expenditures, capital costs of processing facilities, and exploration costs incurred at operating underground mines*, up to a maximum of 33 1/3% of income for exploration and investment allowance in any year.

Processing Allowance: annual rate applied to the original cost of processing assets but not to be less than 15% nor more than 65% of income for processing allowance.
8% of ore concentrated
15% if concentrate is smelted and/or refined in Quebec

Rate applies to all processing assets up to and including final stage.

Quebec Mining Tax Otherwise Payable: subject to 'tax averaging concept' (see below).

income for mining tax	marginal rate
up to 250,000	exempt
250,000 - 3,250,000	15%
3,250,000 - 10,250,000	20%
10,250,000 - 20,250,000	25%
20,250,000 and over	30%

Deduction for Carried Loss: 15% of 'carried loss' in the year following the loss. This deduction can be carried forward for a maximum of four years.

Tax Averaging Concept: based on three-year floating average, including the present year. Procedure:

i determine mining tax payable in present year;

ii determine average annual income for Quebec mining tax for the last three years (including present year) and calculate what mining tax would be payable on this average annual value (note: loss years count as nil tax).

iii multiply (ii) by 3 and deduct taxes actually paid the past two years (excluding present year);

iv pay the lesser of (i) and (iii) in the present year.

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* Actually limited to a prescribed list of exploration expenditures which are a function of such factors as depth of exploration and distance from mine workings.

ONTARIO

Cash Flow Format:

Revenue
- Operating Cost
Net Income before Allowances
- Depreciation Allowance
- Exploration Expenditures
Income for Processing Allowance
- Processing Allowance
Income for Ontario Mining Tax
Ontario Mining Tax

Depreciation Allowance: mine development capital costs at 100% per year; mine plant and equipment at 30% per year on a straight-line basis; mill, infrastructure and all other capital costs at 15% per year on a straight-line basis (and not to be less than 5% per year, irrespective of net income before allowance).

Processing Allowance: annual rate applied to the original cost of processing assets but not to be less than 15% nor more than 65% of income for processing allowance.

8% if ore concentrated
16% if ore smelted
20% if ore refined
30% if ore refined in northern Ontario
35% if ore fabricated in northern Ontario

Rate applies to all processing assets up to and including final stage.

The 16% rate applies to gold mill assets if the facility includes a smelter which produces dore or impure bullion.

Ontario Mining Tax:

income for mining tax	marginal rate
up to 250,000	exempt
250,000 - 1 million	15%
1 million - 10 million	20%
10 million - 20 million	25%
20 million and over	30%

MANITOBA

Cash Flow Format:

Revenue
- Operating Cost
Net Income before Allowances
- Depreciation Allowance
- Exploration Expenditures
Income for Processing Allowance
- Processing Allowance
Income for Manitoba Mining Tax
Manitoba Mining Tax Otherwise Payable
Investment Tax Credit
Net Manitoba Mining Tax Payable

Depreciation Allowance: all capital costs at 20% per year on a declining-balance basis. The amount allowable must be reduced by the investment tax credit (see below).

Processing Allowance: average of 8% per year of the original cost of processing assets* but not to be less than 15% nor more than 65% of income for processing allowance.

Manitoba Mining Tax: 18% of income for Manitoba mining tax.

Investment Tax Credit: 5 percent of capital expenditures on mine development, mine plant and machinery, and processing assets, which have been made for the purposes of bringing a new mine into production, carrying out a major expansion, or 'modernizing' existing facilities to increase production potential.

Allowable capital costs for 'depreciation allowances' must be reduced by the amount of the investment tax credit.

The investment tax credit may be deducted in the year a qualified asset is acquired and can be carried forward for another five years.

* The May 1979 Manitoba budget increased the processing allowance rate from 8 percent to 10 percent per year but restricted the definition of processing assets to exclude common service facilities. Thus, assume 8 percent as an average rate on all processing assets.

SASKATCHEWAN (metallic minerals excluding uranium)

Cash Flow Format:

Revenue
- Operating Cost
Net Income before Allowances
- Depreciation Allowance
- Exploation Expenditures
Income for Processing Allowance
- Processing Allowance
Income for Saskatchewan Mining Tax
Saskatchewan Mining Tax

Depreciation Allowance: all capital costs, except post-production mine development expenditures allowable at 15% per year on a straight-line basis but not to be less than 5% per year. Post-production mine development capital costs allowable at 100%.

Processing Allowance: 8% per year of the original cost of processing assets but not to be less than 20% nor more than 65% of the income for processing allowance for copper-zinc deposits, and not to be less than 15% or more than 65% of income for other deposits.

Saskatchewan Mining Tax: 12.5% of income for Saskatchewan mining tax.

BRITISH COLUMBIA

Cash Flow Format:

Revenue
- Operating Cost
Net Income before Allowances
- Depreciation Allowance
- Interest Payments
- Exploration Expenditures
Income for Earned Depletion Allowance
- Earned Depletion Allowance
Income for Processing Allowance
- Processing Allowance
Income for British Columbia Mining Tax
British Columbia Mining Tax

British Columbia (continued)

Depreciation Allowance: applies to all capital costs. Calculated in the same manner as explained under 'capital cost allowance' and 'development expenditures' for federal corporate income tax.

Earned Depletion Allowance: calculated in the same manner as explained for federal corporate income tax.

Processing Allowance: 8% per year of the original cost of processing assets but not to be less than 15% nor more than 50% of income for processing allowance.

British Columbia Mining Tax: 17.5% of income for mining tax.

Note: all allowances must be taken on an individual project basis.

NORTHWEST TERRITORIES

Cash Flow Format:

Revenue
- Operating Cost
Net Income before Allowances
- Depreciation Allowance
- Exploration Expenditures
Income for Processing Allowance
- Processing Allowance
Income for Northwest Territories Mining Tax
Northwest Territories Mining Tax

Depreciation Allowance: all capital costs except post-production mine development capital costs allowable at 15% per year on a straight-line basis; post-production mine development capital costs at 100%.

Processing Allowance: 8% per year of the original cost of processing assets but not to be less than 15% nor more than 65% of the income for processing allowance.

Northwest Territories Mining Tax:

income for mining tax	marginal rate
up to 10,000	exempt
10,000 - 1 million	3%
1 million - 5 million	5%
5 million - 10 million	6%
10 million and over	+ 1% for each additional $5 million up to 12% maximum

YUKON TERRITORY

Cash Flow Format:

Revenue
- Operating Cost
Net Income before Allowances
- Depreciation Allowance
- Exploration Expenditures
Income for Yukon Mining Tax
Yukon Mining Tax

Depreciation Allowance: all capital costs except post-production mine development capital costs allowable at 15% per year on a straight-line basis; post-production mine development capital costs at 100%.

Yukon Mining Tax:

income for mining tax	marginal rate
up to 10,000	exempt
10,000 - 1 million	3%
1 million to 10 million	5%
5 million - 10 million	6%
10 million and over	+ 1% for each additional $5 million up to 12% maximum

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